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The Abolishment of Capital Punishment. THERE has been not a little public comment on the efforts made to defeat the electrical execution law, followed by the introduction at Albany, last week, of a bill to abolish capital punishment entirely in this State. It seems to us that it is the electrical execution law itself that ought to be repealed. If this were done (as for the sake of electrical interests we trust it will) the whole discussion would soon become ancient history, and we should hear no more of it.

An Electrical Phœnix. ELECTRIC lighting by primary batteries seems to be possessed of a tenure of life hardly explainable by any ordinary method. Every few weeks we receive a new and lurid report of some primary battery scheme which appears to flourish for a brief season on press comments and then dies of inanition, and often as such a scheme is exposed, it disappears from public gaze for a while, only to break out in some fresh quarter under new auspices. These schemes seem to have more lives than a cat, and no ordinary process is sufficient permanently to withdraw them from public attention. One would suppose that the numberless primary batteries which have been brought forward, tested and failed, would be a useful lesson to the long suffering public, but there seems to be no limit to the patience of that much enduring body, or of the protean forms that the primary battery scheme can assume. We refrain from calling attention to the peculiarly chimerical sample which has inspired this comment, but merely suggest that a primary battery for electric lighting is a peculiarly expensive luxury—more expensive no doubt to the investors than the users.

Dynamo Designing. THE section of Mr. Esson's paper which is presented in this issue is a specially interesting one, as it deals with a point in designing which is of great importance and particularly hard to manage successfully—the cross induction produced by the armature. This is a quantity which not only has a profound influence in designing to prevent sparking, but enters in a very prominent way into the problem of compound winding a dynamo so as to give constant potential. It is a fact well known to practical men that the ordinary theoretical rule for compounding, founded on armature resistance, gives only about half the series ampère turns actually necessary to secure constant potential. It is to the demagnetizing effect of the armature that we must refer a large part of this discrepancy, and such papers as this before us give valuable hints to designers as to the proper allowances to be made. In the case of drum armatures a close approximation to the demagnetizing effect can be computed from known formulæ, but in the case of Gramme armatures the problem is more complex, and Mr. Esson's tables will be specially convenient.

A Remarkable Dynamo. THE new Reignier-Bary dynamo, of which an account is given elsewhere in our columns, appears to be a most remarkable machine. The idea of using iron armature conductors to reduce the magnetic resistance is not new, but the composite conductor used by M. Reignier seems to obviate most of the difficulties of the plan, and secures a very low magnetic resistance without producing an objectionable increase of resistance in the armature. The output of the machine is certainly enormous compared with its weight, and the commercial efficiency is such as will compare very favorably with other modern machines. For a dynamo, of course, great weight efficiency is not necessary, nor is it usually economical, but this new machine may well teach a lesson to designers of motors. The dictum that the best dynamo is the best motor does not tell the whole truth, and has diverted attention from what sometimes is very necessary in a motor, the ability to secure a large output with light weight. As, on general principles, rather better results should be obtained in a motor than in a dynamo, the building of this French machine, with its output of a horse power for each 41.5 pounds of weight, points a very distinct moral.

Regulators. WE publish this week a valuable paper by Mr. A. B. Herrick covering a topic of practical importance on which little has heretofore been said. It is often very necessary to design a regulator to fit specific requirements, and the data that are necessary for the solution of the problem Mr. Herrick's paper supplies. Very little, before this paper, had been published on the carrying capacity of wires other than copper, and when in addition one has to consider the case of open spirals, which must not be heated so as to endanger their mechanical properties, the value of the tables contained in this paper becomes apparent. It is interesting to note the great change that is produced in the resistance of iron wire by the heating that a regulator undergoes in service, and as the same is true of German silver, it is clear that great care must be taken not to overheat a coil of fixed resistance. This change seems to be due to a tempering process, as, since it takes place in tinned iron wire, it cannot well be due to oxidation. The suggestions made by Mr. Herrick as to the practical construction and use of regulators are of great value and interest, and cannot fail to be of service to electrical designers, while they raise incidentally questions of scientific importance.

An Important Patent Decision. THE United States Supreme Court has recently rendered a most important decision, which we give in full elsewhere, on the rights of inventors who have secured foreign patents. The Supreme Court holds, reversing the court below, that the lapsing of any foreign patent for cause other than the expiration of the full term for which it may be issued does not terminate the life of the corresponding American patent. This, it will be seen, is a decision of far-reaching effect, and fixes the rights of inventors very distinctly. The now well known refrigerator case of Bate vs. Hammond had of late caused great uneasiness among the holders of foreign patents, and it figured in more than one important case. This last decision puts the whole matter in a very clear light. It does substantial justice to the inventor by protecting him in case of his allowing his foreign rights to lapse by non-payment of taxes or similar cause. It would, indeed, be a hardship if the American inventor, desiring to protect his rights abroad, should find that foreign manufacture was impracticable and his foreign business did not pay, and should be forced into the dilemma of keeping up his foreign patents at great financial sacrifice or forfeiting his rights at home. The present decision discriminates very sharply between the case of a foreign patent lapsing through negligence and expiring by statutory limitation. So much for the effect of a barrel scrubbing machine on the general rights of inventors.

Storage Batteries. IN discussing patent law we are reminded of the changes in storage battery manufacture occasioned by the Faure-Julien suit, emphasized by the recent Brush decision. The dry manufacture of the electrodes has resulted from the Faure-Julien decision, so that the tables have been rather turned. Inasmuch as in the Patent Office interference between Brush and Faure the date of the latter's French patent—not the American one, as we inadvertently stated in the last issue—limited the question of priority, we may have still another revolution in manufacture which by the time the Brush-Faure infringement case is decided will put both the litigants at a disadvantage. Perhaps, after all, the whole legal wrangle, instead of giving any one an exclusive right to the lead storage battery, will give the public a more practical form of secondary pile than has yet been devised. There is nothing like necessity for sharpening one's wits, and the very fact that the present field is from a legal point of view unpromising may produce some very marked changes in the line of progress. Very possibly the coming battery that is to revolutionize the art may have no lead in it at all, and we hope such will be the case, for then we may get a battery that is reasonably light, which would indeed be a surprising novelty.

Report of the Senate Committee. THE committee on general laws has for the past two months been investigating the methods of electric lighting, and has at last made a report, abstracted in another column. An enormous amount of testimony, expert and otherwise, was taken, and the outcome of the investigation demonstrates the care with which it was conducted. The final result may be looked upon by the electrical fraternity as a friendly report, tending to improve the electrical business and establish public confidence. The criticisms made are tendered in a friendly spirit, and the suggestions as to the line of improvement will be for the most part regarded favorably. As was to be expected, the report is unfavorable to overhead high-tension systems in New York city itself, or in general in thickly populated districts. It seems to us that the limit suggested in the report by which underground construction should be used in all cities having 125,000 population or more is rather more arbitrary than wisdom would suggest, for sometimes wires may be so located in cities of that size that they will in no way cause appreciable danger to the public. The committee seems to be thoroughly convinced that the underground system can be successfully carried out, and is emphatic in demanding its use. The limit set by the committee of 250 volts as a safe current, seems to us rather low, especially for a direct current, where it is well established that wires carrying a potential of 500 volts are not dangerous to human life. The testimony taken on the subject of fire risks was particularly interesting, and will undoubtedly tend to re-assure the public and put electric lighting on its proper basis. So far as the much-discussed question of high and low tension goes, the decision of the committee that either can be used with safety to life and property by means of proper and reasonable precautions, is one which is evidently wise and will generally commend itself to electricians. A conclusion drawn from this that it will be unwise and unjust to restrict the voltage of currents used for furnishing electric lighting and power we commend to the attention of those interested and those having the responsibility of legislation on the subject. The high-tension electric current is undoubtedly dangerous, if operated and handled recklessly. So is a buzz saw. But we know of no good reason for prohibiting the use of this latter useful article because careless employés or ignorant bystanders occasionally investigate it with more zeal than discretion. Nothing is to be gained by hiding the dangers of electric lighting, and it is certainly encouraging to note that the committee, while recognizing this, and feeling that a reasonable precaution should be taken, take so common sense a view of the case. Their suggestion that there should be State or local supervision similar to the supervision exercised over steam boilers, is in general a judicious one, but we fear that it will be by no means easy to give it in a way satisfactory either to the public or the electric light companies. The feature of the report that we feel most inclined to criticise is the wholesale denunciation of overhead wires. It may be advisable under certain circumstances to allow high-tension wires even in the streets of a city. It seems hardly advisable to prohibit the overhead system by rigid legislative enactment, as it is a subject more properly to be dealt with by local authorities. It is a very difficult matter to provide regulations for so complicated and rapidly changing an art as that of electric lighting, and we are strongly of the opinion that any sweeping measures passed on the subject will have a bad effect. Common sense and good local supervision ought to dispel most of the difficulties that we at present have to deal with.

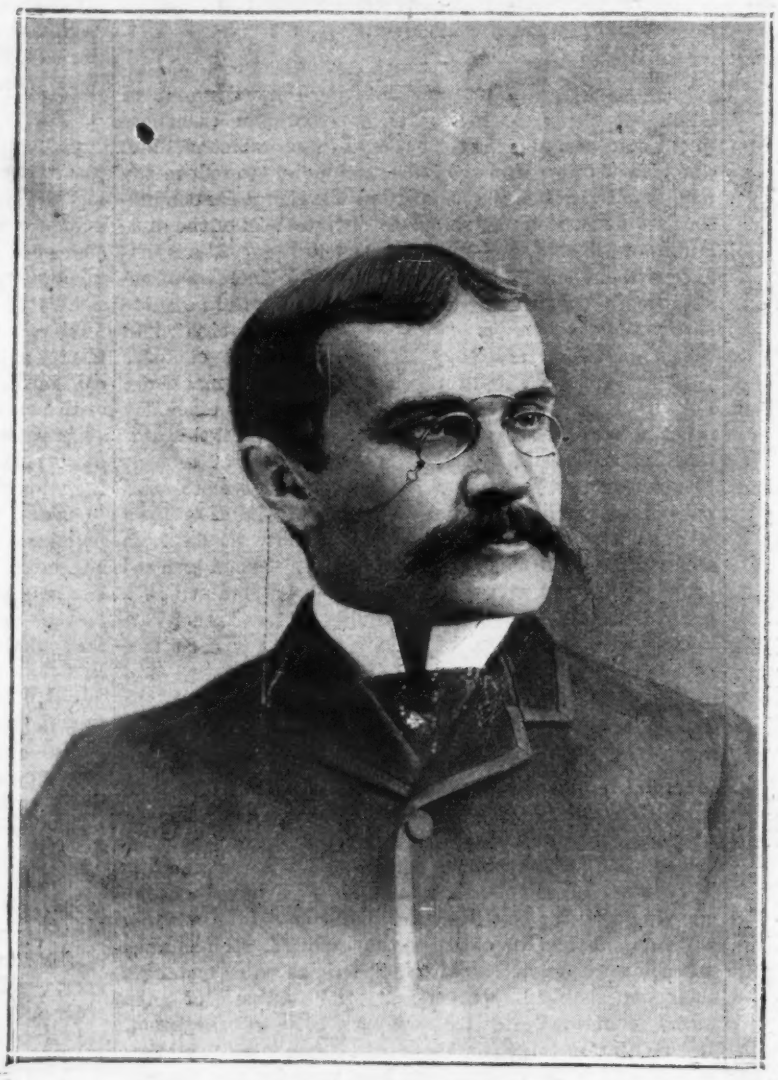
ELECTRICAL WORLD PORTRAITS.—XIII.

DOCTOR LOUIS DUNCAN.

We are fortunately able to give herewith a portrait of Dr. Louis Duncan, whose able and interesting paper we print in this issue. Dr. Duncan is one of a little circle of young men who have combined valuable practical experience with a most elaborate technical and theoretical education. He was born in Washington, D. C., in 1862. He received his primary education at private schools until in 1876 he entered the United States Naval Academy at Annapolis, where he made an enviable record as a scholar of no ordinary merit. After graduation he was sent to sea, and remained on the South Pacific station for two years. At the expiration of that time he was ordered to land service, and stationed at the Johns Hopkins University at Baltimore, where he remained for three years, devoting nearly all of his energies in the theoretical and practical study of electricity. During that time he assisted in the labor of the determination of the value of the ohm, made for the United States government, and conducted various other valuable investigations. In 1885 he took the degree of Doctor of Philosophy at that institution, having previously served as one of the judges at the international electrical exhibition at Philadelphia, and as chairman of a committee which made efficiency tests of dynamos and incandescent electric lamps. While engaged in that work he was elected an honorary member of the Franklin Institute, and the tests he conducted are standard literature on the subject of dynamo efficiency. In 1885, after receiving his degree, he was ordered to sea and was employed on special service for a year, testing various electrical devices for naval use.

In 1886 he resigned from the navy and accepted a position as associate professor of electricity in Johns Hopkins University, where he took charge of the course in electrical engineering which was then established. Since that time he has been engaged in a series of most valuable and practical researches bearing especially on the means for improving the efficiency of methods of electrical distribution. He devised a practical process of testing converters, calorimetric, a method which has since come into wide use, and has spent no little time in the study of the very complicated actions that go on in the storage battery. His contributions of exact scientific research in the field of practical electricity have been of great value, and have placed him high in the ranks of American electricians.

Dr. Duncan is a member of the American Philosophical Society, a Vice-President of the American Institute of Electrical Engineers, and one of the three American members of the Mathematical Society of France. His career up to the present has been a brilliant one, and those who have followed his work look for a long continued series of researches which cannot fail to add much to our scientific knowledge of practical apparatus and methods.



DR. LOUIS DUNCAN.

A Rival.

Electrical traction engineers will be interested in a rival system of driving tramcars lately tried at Chester. This is a low-pressure compressed air system, introduced by Messrs. Hughes & Lancaster. A number of experiments have been carried out by Prof. Unwin, F. R. S., on the Chester Tramway Company's line, who is stated to have expressed his satisfaction with the system as being practical and less costly than horses. In this system the air is compressed to 170 lbs. per square inch at a station, and is delivered into mains laid at long intervals alongside the tram line, just below the surface of the roadway. A supply of air is picked up along the route by the car as a fresh charge becomes necessary, and is stored in a receiver. The motor is on the car itself, which, in outward appearance, resembles an ordinary horse car, and the car with its freight moves along without any visible agency whatever. At intervals along the route of the tram line are boxes set into the ground, and having a hinged cover flush with the roadway. Inside each of these boxes is a valve connected with the air main through which compressed air is supplied to the car, and these are termed charging stations. The method of charging is ingenious and simple, and the operation occupies only a few seconds. As the car passes along, a kind of plough is lowered as the car approaches the charging station at a reduced speed. This plough raises the cover of the box, and at the same time, by means of an ingenious valve arrangement, connection is made automatically between the air reservoirs on the car and the charging main. The car is stopped for a few seconds, and upon being restarted the connection with the charging main is automatically broken, and the hinged cover of the box falls down in place. The car is started by admitting the air to the motor, which in the present case is one of Rigg's four-cylinder engines. The attention which is being given to mechanical methods of traction by tramway companies is not confined to electrical systems. We are far from saying that the above-mentioned system is a powerful rival, for as yet no full particulars are furnished, but it is evident that the companies do not intend to capitulate to electricity without a side struggle, and if they think they can do what they wish with compressed air some will try. It lies with the electric companies to find out the advantages or disadvantages of the air system, and push strongly home the advantages they can prove of the electric system. The field will not be won without a struggle.

A Daring Project.

It would be singular indeed if the first long distance-electric road should be established in far-away Russia. We here in America are pushing electric traction so rapidly and successfully that it is here we would naturally look for such an important extension of the matter.

There is, however, an interesting project being pushed at present in St. Petersburg. This is nothing less than an electric railway connecting St. Petersburg with Archangel, spanning a wide stretch of country that lies between the Baltic and the White Sea. The project is said to be backed by Archangel interests, and the name of Siemens & Co. is connected with the enterprise.

The plan is to furnish the current from a series of generating stations distributed along the line. The distance is something over 500 miles, and the estimated cost a little over $15,000 per mile, including rolling stock.

The scheme is certainly a daring one, and while it may never reach accomplishment, further progress would be waited with interest on this side of the Atlantic.

Complimentary Dinner to Mr. Law.

On Saturday night last a dinner in honor of Mr. Myron D. Law was given by a number of his electrical and other friends at the Colonade Hotel, Philadelphia, prior to Mr. Law's departure for Denver, Colo. Mr. F. W. Whiting, of the Board of Fire Underwriters presided, and Mr. H. A. Cleverly acted as toastmaster. There were also present Mr. D. R. Walker, Chief of the Electrical Department of the city of Philadelphia; Professor W. D. Marks, of the Edison Electric Light Company; Messrs. A. J. De Camp, Secretary Brush Electric Company; C. W. Spear, of the Brush Electric Illuminating Company, of New York; F. W. Griffin, H. B. Cutter, C. E. Stump, J. C. Sager, F. R. Colvin, F. A. Lee, W. E. Mellor, W. A. Porter, W. K. Fox, W. A. Drysdale, W. McDevitt, L. H. Spellier, A. Shearer, and J. E. Shaw. After a most enjoyable dinner had been partaken of, Mr. Law was presented by Mr. H. B. Cutter with a very handsome autograph album containing the signatures of the subscribers to the dinner. He was afterward the recipent of a fine non-magnetic gold watch, appropriately inscribed, from the directors of the Brush Electric Company, of Philadelphia, in recognition of his services to that company. The presentation was made by Mr. De Camp, on behalf of the Board of Directors.

Mr. Law, who has been for the past nine years superintendent of the Brush Electric Light Company, of Philadelphia, has accepted the management of the Consolidated Electric Company, of Denver, Colo. The proceedings at the Colonnade Hotel must be a highly gratifying evidence to him of the esteem in which he is held by his many friends personally and of their appreciation of his qualities as an earnest and indefatigable worker in the field of electric lighting.

Quick Work on the Cable.

Some particularly lively telegraphing was done in reporting the Oxford-Cambridge boat race of March 26. The finish at Mortlake was 5:06.30 P. M. Forty-five seconds later news of the result was as far as the English end of the direct cable, and at 5:08 P. M. the story was told at the American cable terminals. One minute and thirty seconds for covering 3,000 miles is quick work and speaks volumes for the efficiency and rapidity of modern cable service.

Telegraphic Communication Between India and China.

There is every probability that in the near future a through land line of telegraph from India and China may be opened. The wires now stretch as far eastward as Bhamo, and the China Government some time ago hadextended their western lines as far as Yung Chang, thirty miles east of Momein, in the Yunan Province, and not more than 130 miles from the northeastern frontier of Upper Burma.

Strasburg.

The first German Catholic church to be lighted electrically is the Strasburg Cathedral. Arc lights have been used outside with grand effect, and inside with incandescent lamps disposed round the piers and columns. It was feared that the electric light would spoil the dim and religious effect. It is true that the piers are more brightly lighted, but the interior as a whole is said to be highly satisfactory.

Electrical Statistics.

To the Editor of The Electrical World :

SIR—Will you kindly state in your paper, or to me, answers to the following questions :

1. How many arc lights are burning in the United States?
2. How many incandescent lights?
3. How many motors in use?
4. How many street railways equipped in all or part by electricity?
5. What is the highest voltage in use in the United States?
6. What is the longest distance that light or power is carried in the United States, and where is it?

You will confer a great favor by giving even approximate figures on the foregoing.

Yours very truly, J. L. NOTT.

[It is a difficult matter to give anything but roughly approximate answers to the above questions, for changes take place so rapidly that an answer given now could not be taken as correct a week hence on account of the enormous growth of electrical industries. As near as we can estimate, however, the following are the facts:

1. Probably 235,000.
2. About 3,000,000.
3. No very definite figures are at hand, but 18,000 would probably be a fair estimate, very many of them being less than 1 h. p.
4. The latest estimate we have seen gives the number of street railways equipped or under contract as nearly 300, over 1,500 miles of track, and probably 2,500 cars.
5. The highest voltages in use are those of the arc lighting circuits. We think that about 3,000 volts is the highest pressure in regular use, and that is probably used but seldom. The largest single arc machines manufactured require approximately that voltage at full load. A year or two ago one of the large electric lighting companies had two 45-light machines coupled in series for a time, which would have required a voltage of over 4,000. We think 3,000 is practically the limit, however.
6. The longest distance to which electrical energy is transmitted in the United States may unquestionably be found on the line of some one of the electric railroads. Without any details as to the location of the power stations with reference to the terminals of the roads in the large systems, it is hard to give the location. It is quite likely, however, that the longest distance transmission will be found in the St. Paul-Minneapolis Electric Railway system now under construction. The exact distance we cannot give.—ED. E. W.]

The Dynamo Room of Edison's Laboratory.

We present herewith a large illustration of an electric light station decidedly out of the ordinary run. It is the experimental station in the great Edison laboratory at Orange, N. J. The dynamo room shown in Fig. 1 is beautifully fitted up and contains a much larger variety of machines than is usually to be found.

The power is furnished by two 135 h. p. Armington & Sims engines, and the machines driven are the following: One No. 20 incandescent machine, two No. 12 incandescent machines fitted for use on the three-wire system, one high potential Municipal dynamo, one No. 8 incandescent machine, and one machine of an older type, giving 1,000 ampères at a low potential of five volts. This latter is used in experimental work, more especially in connection with Mr. Edison's magnetic separator.

This varied equipment furnished light and current for almost any amount and kind of experimental work that could be attempted. Like everything else about the Edison laboratory, the dynamo room is thoroughly well equipped, and is a model of convenience. Connections with the machines are made by copper bars shown in the cut running along the sides of the room. On the wall at the further end of the room is seen a large and complicated looking switch, shown in more detail in Fig. 2. This switch is the only one of its kind, and was designed at the Edison laboratory. Its purpose is to change the connection of a pair of dynamos running on the three-wire system, so as to convert the distribution into a pair of two-wire systems. All this is accomplished by a single movement of the switch lever. The connections are quite complicated, and the switch is a massive one, but it has been found very convenient in practical application.

Continuous Outputs of Two-Pole Dynamos and Motors.*

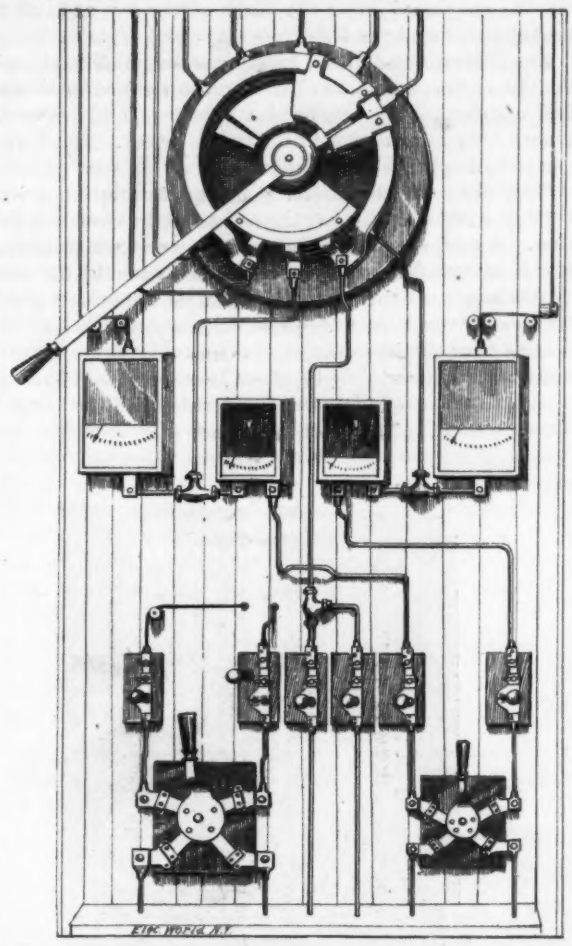
BY ALBION T. SNELL.

The following equations are intended for the use of engineers in charge of electrical plants, and demand no special electrical knowledge, the measurement being made by a foot-rule. They give approximately the safe average output of dynamos and motors *for continuous running*, and are based on observations made during the past few years with machines of nearly all the best manufacturers. They, of course, only average the results, and so will not give a sufficiently high output for machines of abnormal proportions, *i. e.*, with unusually heavy fields, or very deep armature cores. With very light machines the formulæ will give results too high.

*From *The Electrician*, March 14.

With normal machines the outputs given by these equations will generally be about ten per cent. lower than that given in the price lists. This margin is made to meet the contingencies incidental to continuous running.

The outputs are expressed in terms of the armature lengths and diameters and the numbers of revolutions per minute. The constants are carefully determined from a large number of tests. (They depend on the fact that the average magnetic induction through an armature is determined by the effective area of the iron and the magnetic density per unit area. For a given field excitation the total induction will be sensibly constant through considerable variations of radial depth of armature. This is apparent when we consider that the conductivity of the armature iron bears but a small proportion to the conductivity of the magnetic circuit as a whole, and hence an increase of iron will not largely increase the total induction, but will almost always decrease the induction per unit area.) The outputs of dynamos are given in watts (746 = 1 h. p.). Those of motors are given in brake horse power. The linear measurements of the armatures are made in inches; l = the length of the armature parallel to the shaft. In the case of cylinders the length may be taken over all; *i. e.*, from one end of the winding to the other. In drums, only that part of the armature covered by the pole-pieces must be measured for the value of l. The outer diameter d of the armature is measured over the windings. The revolutions per minute can be taken by a speed indicator or counter.



SPECIAL SWITCH BOARD AT THE EDISON LABORATORY.

For two-pole dynamos:

l = length of armature in inches.
d = diameter of armature in inches.
r = number of revolutions per minute.

Drum Armature: $l\,d^2\,r\,.015$ = output in watts . (I.)
Cylinder armature; $l\,d^2\,r\,.01$ = output in watts . (II.)

For two-pole motors (symbols have the same signification):

Drum armature: $l\,d^2\,r\,.000015$ = b. h. p. . . (III.)
Cylinder armature: $l\,d^2\,r\,.00001$ = b. h. p. . (IV.)

With a four-pole machine, since for the same magnetic density in the armature double the field excitation required for a two-pole machine is necessary, the *constant* must be multiplied by *two*. Some four-pole machines, however, have very light fields, and then the output is given nearly correctly by the formulæ. Generally, with machines of more than two poles the equations will only be useful for determining the safe load for a *first run*. If the heating be very little the output can then be gradually increased until a suitable load be obtained.

The following examples, chosen at random, show the method of applying the formulæ to various machines:

Edison-Hopkinson Dynamo.—Drum armature, 9¼ in. in length, 10 in. in diameter, 970 revolutions per minute.

Equation (I).

$$9.75 \times 10^2 \times 970 \times .015 = 14{,}200 \text{ watts.}$$

The output is given at 15,700 watts.

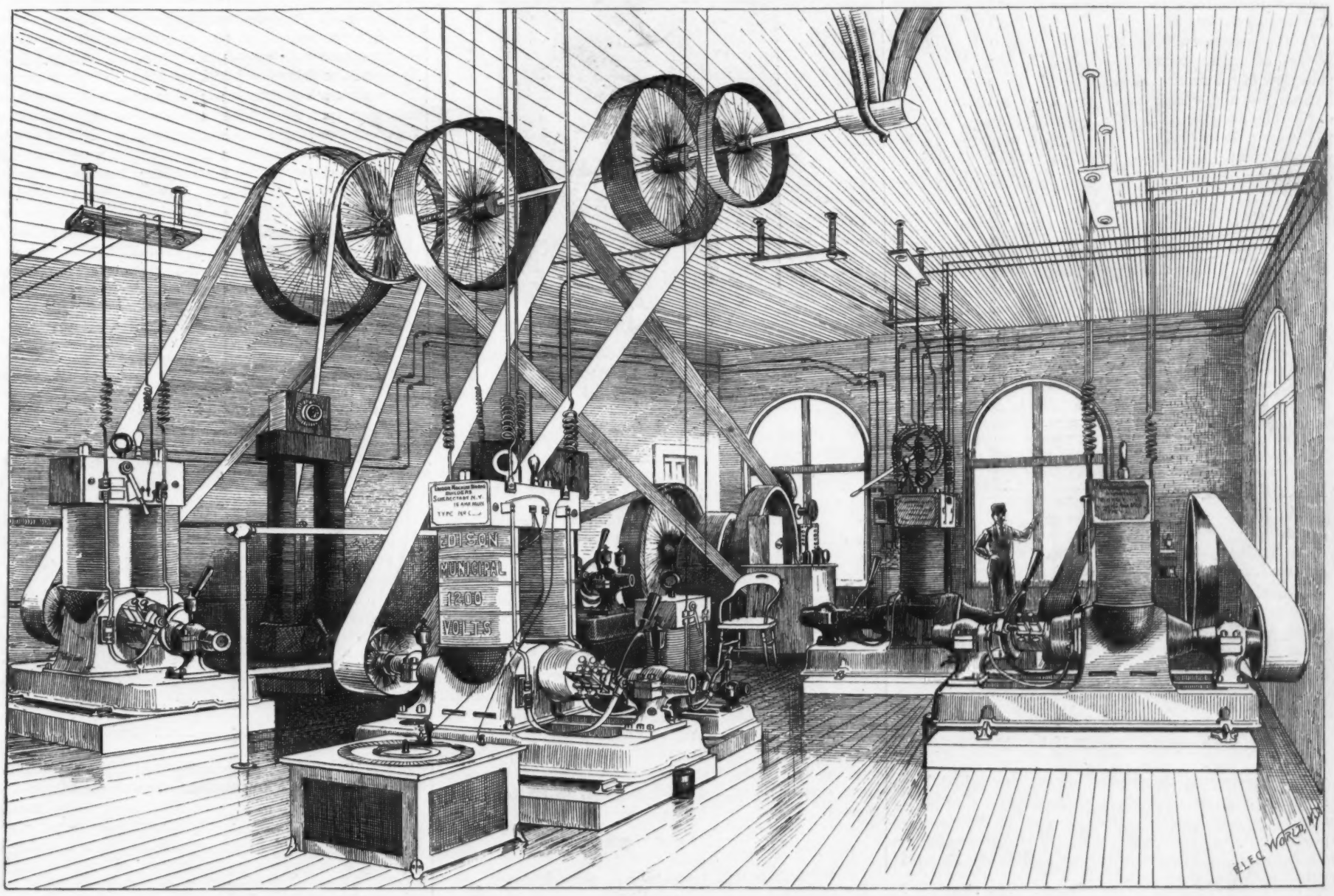
Paterson and Cooper Dynamo.—Cylinder armature, 10 in. in length, 13.5 in. in diameter, 850 revolutions per minute.

Equation (II).

$$10 \times 13.5^2 \times 850 \times .01 = 15{,}500 \text{ watts.}$$

The actual output is given at 16,200 watts.

Immisch Motor.—Drum armature, 14 inches in length, 7.25 inches in diameter, 1,000 revolutions per minute.



THE DYNAMO ROOM AT THE EDISON LABORATORY, ORANGE, N. J.

Equation (III).

$$14 \times 7.25^3 \times 1000 \times .000015 = 11 \text{ b. h. p.}$$

This machine is actually designed to give 10 b.h.p.

Immisch Motor.—Cylinder armature, 16 inches in length, 24.5 inches in diameter, 450 revolutions per minute.

Equation (IV.).

$$16 \times 24.5^3 \times 450 \times .00001 = 43.2 \text{ b. h. p.}$$

The actual horse power given continuously by this motor is between 44 and 45.

The writer has found these equations of great assistance

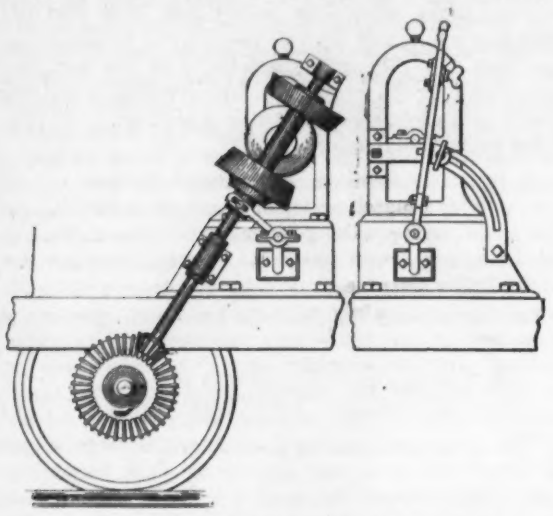


Fig. 1.—Henry Electric Motor System.

in selecting the size of armature for a given machine before making more complete calculations.

The Henry Electric Railway.

We illustrate in this issue some of the electric traction devices of Mr. J. C. Henry, one of the earlier workers in the field. The present apparatus, for which a patent has just been issued, is specially interesting as being one of the solutions of a problem on which more than one electrician is now working; that is, to devise some means of connecting the electro-motor to the car wheels which shall admit of the former running continuously in the same direction, irrespective of the direction or motion of the car.

Just now this particular problem is coming to the front, and several devices to the same end will shortly appear.

In the accompanying illustration we see Mr. Henry's method of accomplishing this object. In Fig. 1 is shown a side view of the motor and the connecting gears. As will be seen, the motor is placed on the front platform of the car and its armature, instead of being connected directly to the car axle by chains or gears, acts on a pair of friction wheels mounted upon a movable collar, which drives an oblique axle, carrying on its lower end a gear wheel to en-

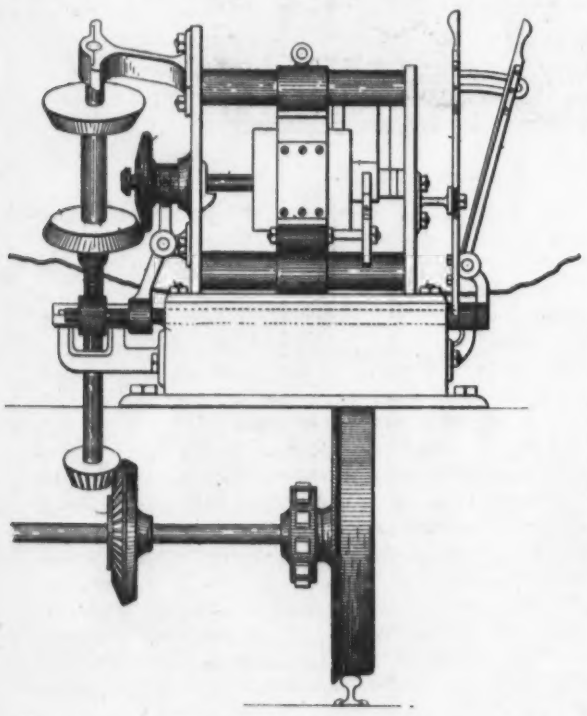


Fig. 2.—Henry Electric Motor System.

gage the driving wheel mounted on the car axle. By a lever on the car platform either of the friction wheels can at will be engaged with the friction wheel on the armature spindle, and consequently the oblique shaft can be given a rotation in either direction without changing the direction of the rotation of the motor.

Other devices give the oblique shaft sufficient play to allow for vibration in the car.

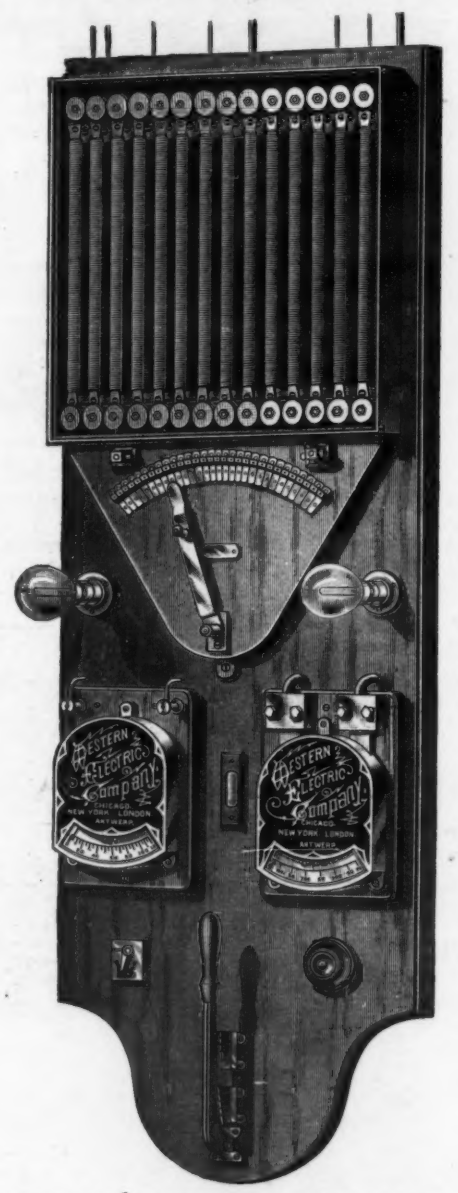
The friction wheels used in practice are of wood and are reported as giving a firm hold and excellent service.

In Fig. 2 is a perspective view of the apparatus showing more clearly the method of connecting the driving gear with the armature. It will be readily seen that the motor is normally running whether the car is in motion or at rest; and the car can be started, stopped or reversed by shifting the collar carrying the friction wheels along its shaft.

The experiments tried with this mechanism have been quite satisfactory in their character, although the illustrations shown represent an early form of apparatus. Mr. Henry is now at work improving and modifying it, and in his later arrangements the motor and the driving devices which are mechanically, however, equivalent to those shown, are placed below the floor of the car, as in all the recent motor systems.

The patent issued to Mr. Henry covering this device also contains some important claims on the method of sustaining and arranging overhead conductors, and has undergone a long interference in the patent office. The text of the patent appears in this issue.

Such devices as this of Mr. Henry are interesting as illustrating a probable line of improvement in street car traction. A motor is working at its very worst when starting, and if successful means can be devised whereby the strain of starting is not thrown suddenly on the motor, but gently, and, as it were, in a flexible manner, through friction wheels or equivalent devices, the necessary strain upon the apparatus will certainly be much lessened. Of course the ultimate value of inventions of this kind can only be ascertained in actual practice, but the mere fact that there



Combination Incandescent Switchboard.

is general interest in devices of this character, shows that we cannot regard them as unimportant.

The illustrations display the principles very well. The details of Mr. Henry's later models will be awaited with considerable interest, especially as they include not only modifications of this driving device, but also because they are a reversion, one may say, toward running a single motor to drive the car instead of two motors, as ordinarily practiced. Just now there seems to be a growing feeling that the decision in favor of two motors for a car was rather hastily made. It is to be hoped that experiments will soon be tried to review the data and investigate the claims of a single motor system. Most devices of the sort shown will certainly require the use of one motor, since it would be a matter of no small difficulty to distribute the load in any equitable manner between two motors, each acting through a friction gear, or an equivalent thereof.

Combination Incandescent Switchboard.

The accompanying illustration shows the dynamo rheostat, ammeter, voltmeter, ground indicator and main switch, all mounted upon a finely finished hard wood board. All wires are placed and connections are made on the back of the board, and the instruments can be readily placed and properly connected for service. This board, as shown, is furnished by the Western Electric Co. with all their incandescent dynamo outfits, where but one dynamo is required.

The Hawkeye Double Pole Cut-Out.

The Central Electric Company, of Chicago, are placing upon the market an extremely neat and practical double pole cut-out mounted on a porcelain base and having a porcelain cap. Fig. 1 shows the inside arrangement of the device, and Fig. 2 shows the cut-out, with the cap in position, as it will look when placed in service.

This cut-out possesses features that we think will be recognized by all practical construction men.

A New and Remarkable Dynamo.

At the last *séance* of the Société des Electriciens, M. Reignier gave some interesting particulars with regard

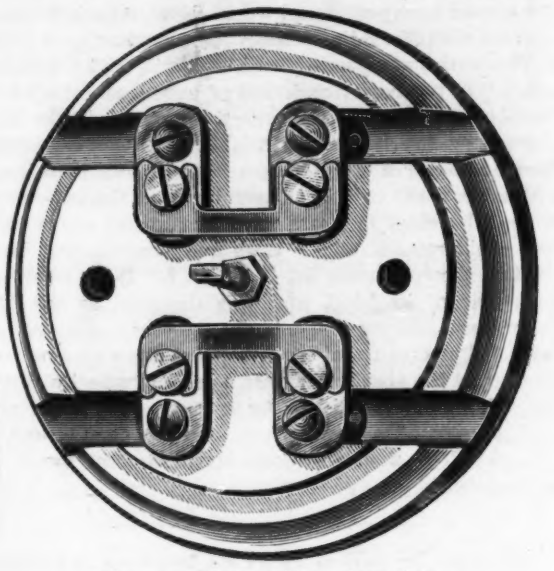


Fig. 1.—Double Pole Cut-Out.

to the machine he is constructing in conjunction with M. Bary, and which I have alluded to in a previous letter. MM. Reignier and Bary have made a great point of reducing the resistance of the magnetic circuit. By diminishing this they have been able to employ a very small magneto-motor force, and consequently to greatly diminish the weight of copper; and the total weight of the machine for a given output is, therefore, at the same time considerably reduced. The method adopted by M. Reignier for reducing the resistance of the air-gap consists in winding the armature with a conductor composed largely of iron. The machine described by M. Reignier is of the ring type. The armature conductors are compound, and consist of a strip of copper, sandwiched between two strips of iron, and kept together by the insulating covering. But as in a ring the external surface is larger than the internal surface, the strips of iron are only on the outside. The machine, which has actually been constructed, has an output of 10.5 kilowatts (70 volts and 150 ampères) at a peripheral speed of 10 meters per second (33 feet per second), and at an angular velocity of 1,800 revolutions per minute. The machine weighs 263 kilogrammes (580 lbs.) Its output for weight is thus 40 watts per kilogramme (18.2 watts per lb.) This

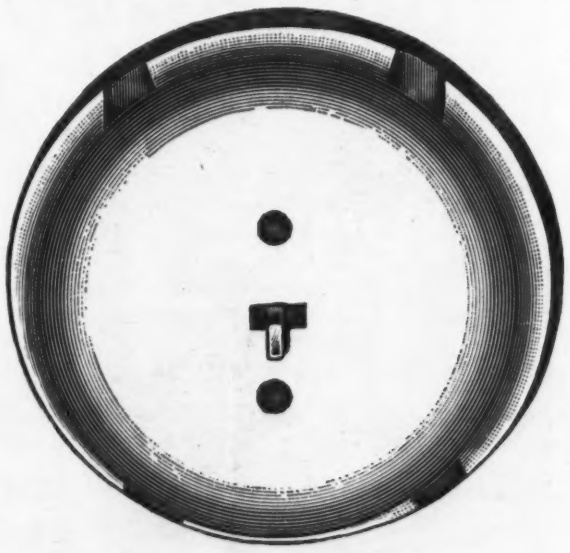


Fig. 2.—Double Pole Cut-Out.

figure is undoubtedly far superior to any hitherto obtained; and here are some comparative figures on the subject:

Watts per kilogramme.	Edison.	Desroziers.	Rechniewski.	Reignier-Bary.
Machine	9	21	215	40
Armature copper ..	500	—	800	1,800
Total copper.....	92	250	270	445

I should remark that the figures of the Rechniewski machine correspond to a peripheral speed of 16 meters per second (52.3 feet per second). The efficiency tests of the Reignier-Bary machine were made at the Laboratoire Central d'Electricité, and the electrical efficiency was found to be 94 per cent., and the commercial efficiency 90 per cent. We are thus able to see that, without diminishing the efficiency, Messrs. Reignier and Bary have been able to increase in a very large degree the *puissance specifique*. The advantages of this are so self-evident that it is not worth while to mention them further.

The Thomson Protective Device.

While sensational articles in the daily press have done much to exaggerate the danger of the electric current, especially of the alternating system, and while these articles happily cannot be substantiated by facts, it is useless to maintain that high potential currents can be handled with impunity. On the other hand, however, it is unquestionably a fact that they can be handled without danger to life or property if ordinary common sense precautions are taken.

In the use of electrical apparatus of any description whatever, it is the best, and therefore the only proper

THOMSON PROTECTIVE DEVICE.

practice, to use in construction such care and devices as will eliminate entirely all liability to accident or injury.

The Thomson-Houston Electric Company, in all installations of alternating current apparatus for incandescent lighting, employs the protective device, shown in the accompanying illustration. It is a simple, but effective, appliance for removing the possibility of accident which might arise from contact with the secondary circuit.

There are three conditions which must be simultaneously satisfied before this possibility can be said to exist.

1st. There must be a ground on the primary wires.

2d. There must be a contact between the primary and secondary coil in the transformer.

3d. The person must be in contact with the secondary and the earth at the same time.

The fulfillment of the first of the above conditions is of common occurrence, but the presence of a ground can be easily detected, and means can be at once taken to remedy the trouble.

The second condition is met with seldom, and is only liable to occur when transformers are injured or subjected to rough usage in shipment.

The third condition rarely obtains.

The remoteness of liability to accident is quite apparent when it is remembered that these conditions must be simultaneously satisfied, and even then the extent of the injury depends upon the relative position of the contacts with reference to the two primaries.

As the fulfillment of the above condition is, of course, not beyond the range of possibility, the device herewith

EDISON TWO-LAMP PRESSURE INDICATOR.

described has been designed to prevent any injury resulting from a contact with the secondary wires when these requirements are fulfilled. It consists of three press terminals, to the central one of which is rigidly attached a flat brass spring pressing against the two outside terminals, but normally held out of contact with them by slips of paper film. This paper film is very carefully prepared, so that it readily withstands the pressure of the spring, but is instantly ruptured when the first and second conditions, mentioned above, are satisfied. To the central terminal is attached, by means of a binding screw, a wire connected with the earth. To the inside terminals the secondaries are led directly from the transformer. When the difference of potential between the earth, with which the brass spring is in contact, and either one of the outside terminals, to which the secondaries are attached, should rise beyond the normal pressure, the paper film is at once punctured. This results in short circuiting the secondary, which causes the fuse to blow, thereby cutting out the entire installation.

Edison Two-Lamp Pressure Indicator.

This instrument represents the latest improvement in the type of pressure indicators which are so successfully used in connection with Edison plants.

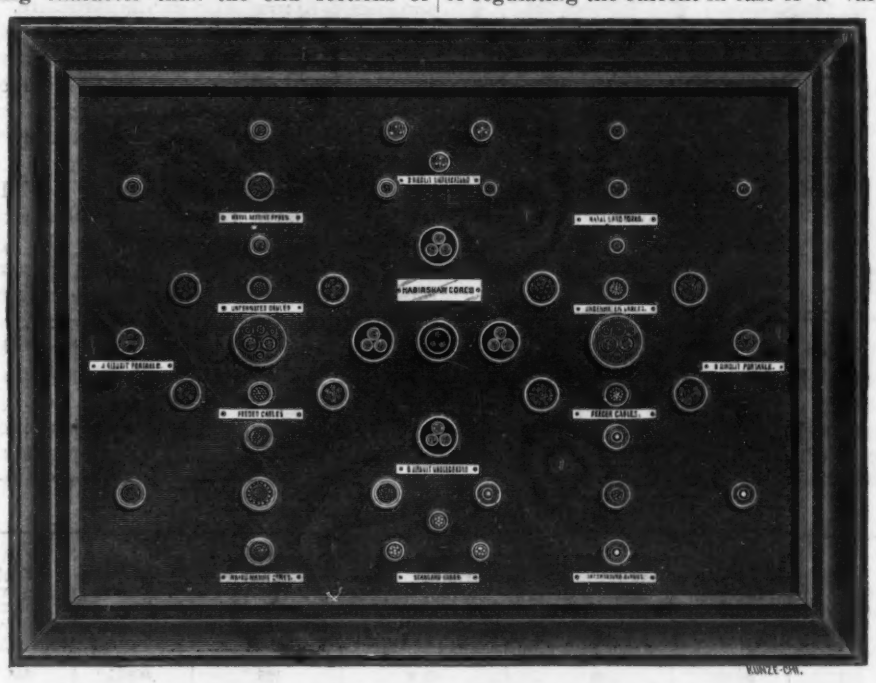
It being found that the carbon filament in the lamp on the one-lamp pressure indicator changed in time as it was burned, it became necessary to recalibrate the indicator in order to maintain correct indications. It became necessary then to put in the instrument a means by which the engineer operating the plant could quickly and easily re-standardize his instrument.

This improvement virtually consists in the connecting two indicators through a switch to the same points in the circuit, using one as a working indicator to be kept constantly in circuit, while the other should be kept out of use until such time as it was thought necessary to throw it in, in order to check the other. This is done in one instrument by putting on two lamps and two sliding resistances, and so connecting them with a switch that when one lamp is lighted one slider is to be used, and when the other lamp is on the other slider is in use.

In the two-lamp pressure indicator, as shown in the cut, the "test" lamp is the one to be kept for a check, while the "work" lamp is to be burned.

An Artistic Sample Board.

To the majority of the practical members of the fraternity who visited the display in the Casino during the late national meeting at Kansas City, few exhibits were of a more interesting character than the end sections of



AN ARTISTIC SAMPLE BOARD.

various cables and single conductors surrounded with Habirshaw insulation that were so tastefully arranged on a sample board of highly polished solid mahogany, in the quarters assigned to the Electrical Supply Company, of Chicago, an illustration of which is shown on this page. Briefly described, the cores range in size from one-half an inch to 2½ inches, and from 5,000 circular mills to 700,000 circular mills. The four small sections in the lower right hand corner were cut from the cable used in the underground Edison circuits at the Jersey Central Railroad depot in New York. The two largest sections are from the Easton cable now lying in the Delaware River, and conveying the Edison current, while the twelve surrounding sections are from the cables operated by the Brooklyn Edison station, and range in size from 250,000 to 700,000 circular mills.

The naval marine cores were taken from cables now in use on the various government cruisers, while the leaded land cores are in use in the Brush incandescent installation in the Interior Department at Washington. One fact that adds to the value of the display is, that every core displayed on the board is a section of a cable in actual daily use in some prominent installation, and not made up for exhibition purposes only.

Dry Batteries.

Several of our correspondents have recently written, calling our attention to the interest that seems to exist at present in a dry battery, for certain classes of work. The dry form of cell possesses marked advantages, for the reason that its action is not at all interfered with by its position or the rough usage to which it may be subjected, provided the cell is not broken. The principal difficulties that have heretofore been met are low efficiency and expense of manufacture, but there seems to be no reason why, for the class of work alluded to, the dry battery should not fall into general application. The latter developments in this line have been in the direction of providing material which is not merely absorbent for filling the cell. The older batteries were filled with almost any material that would take up the exciting liquid, but, the more recent ones have employed gelatinous masses of various sorts, some of which possessed exciting properties. The using of sparingly soluble salts for forming a part of the exciting material has been suggested recently. One of our correspondents sends us the results of his experience with dry batteries, and the facts presented by him go to show that the dry battery may be more generally useful than it has been. He has been for some time using a six candle power incandescent lamp to illuminate a clock face by night, so that by simply pushing a button sufficient light is given to see the time readily without the annoyance of striking a match or of keeping a light constantly burning. To excite this lamp are used 8 cells of dry battery, and it is found that they readily give a current sufficient for the purpose.

This result is certainly encouraging as showing a very tolerable degree of efficiency and thoroughly useful properties. Our correspondent concludes his account of this utilization of the dry battery by emphatically expressing his opinion that it has come to stay.

Regulators.

BY ALBERT B. HERRICK.

Where electrical energy is transmitted from one point to another, the transmission is most economical when the current is transformed into the least number of heat units or the drop in volts is the least. But in using a conductor for the purpose of reducing, in case of a permanent resistance, or regulating the current in case of a variable resistance, the wire forming this resistance is used at its greatest economy when the greatest number of heat units are developed in the conductor; or when a conductor carries the maximum current which it can stand, the greatest drop in electromotive force is obtained with a given weight of wire. This leads us to the theoretical conclusion that just below the fusing point of the metal forming the resistance is the point at which it is used with the greatest economy in regard to weight and space.

The formulæ which Mr. A. E. Kennelly has deduced from his exhaustive series of experiments on the heating effect of currents in copper conductors, bare insulated, and under various practical conditions, leave little to be desired on this point; and, on the other hand, A. H. Pierce's carefully compiled tables, showing the current in ampères required to fuse wires of various diameters and materials, are accurate data on conductors carrying abnormal currents; but in using a conductor for resistance in construction of regulators they have to be worked between these two conditions.

Any conductor can be used as a resistance; but there are a number of practical conditions which arise, and in commercial work there is found only a very limited number used. Liquid conductors with movable electrodes are perhaps one of the oldest forms of regulators. Acidulated water with lead electrodes is very often found to be the most convenient way to make up a resistance for experimental work; a regulator so made gives a fair resistance for rough work, but they are not reliable on account of the gases evolved at the electrodes, which constantly varies the resistance, making them very inconstant in their action. Saline or acid solutions, when used as conductors, are very sensitive to slight changes in temperature and density. In Clark and Sabine's "Rules and Formulæ" are to be found the resistances and conductivities of those saline and acid solutions which are generally used. Such forms of regulators have neither stability nor portability.

In practice we find regulators which are made by using metallic conductors, and these conductors can be readily manufactured into resistances meeting all the requirements demanded of them in practical work where the regulation of the current is desired.

A number of methods have been tried by means of which a conductor could be used as a resistance at a very high temperature,or near its maximum efficiency. The wires or strips have been imbedded in a non-conducting substance so that the wire can be used at a higher temperature than is permissible where the mechanical strength of the resistance wire is depended on in the construction of the regulator; the non-conductor in which the wires are imbedded would have to be fire-proof in order to use the wires at a high temperature. It has been found in practice that there are no real advantages in this method, for we would have to work the conductor under very disadvantageous conditions. Having prevented all possibility of the conductor cooling by convection, the only method left of dissipating its energy is by conduction and radiation through the surrounding non-conductor. Such cooling takes place so slowly that a conductor carrying a current that would raise its temperature to 115 degrees Cent. when exposed to the air would in time be melted if it were imbedded in a non-conducting substance, although its fusing point is about 1,800 degrees centigrade.

Where stability of resistance is required this method is plainly out of the question, as may be seen from Table I., where it is shown that a conductor after having been raised to a high temperature has its resistance materially changed.

TABLE I.

Iron Wire. Temperature.	Resistance.	Copper Wire. Temperature.	Resistance.	Platinum wire. Temperature.	Resistance.
0° C.	640	0° C.	814	0° C.	1,870
21° C.	691	21° C.	864	21° C.	1,986
285° C.	1,680	Scarcely incandescent.	2,100	Barely incandescent.	4,300
Commencing to color	2,250	Carmine red	2,450	Red hot.	4,700
Dark grey.	2,460	Brick red.	3,300	Light red.	5,050
Scarcely incandescent.	3,050	Bright red.	4,700	Orange.	5,400
Dark red	3,200	21° C.	910	Light yellow	6,000
Bright red.	3,650			21° C.	1,984
Red hot.	4,550				
White hot.	4,880				
21° C.	727				

It also may be noticed from this table that for each degree between zero and 21 degrees Cent., the average increase of resistance per degree is very small when compared with the increase between 21 degrees Cent. and 285 degrees. In the case of iron wire for instance, the average increase per degree below 21 degrees Cent. is .39 of one per cent., whereas between 21 degrees Cent. and 285 degrees, the average increase per degree is $27\frac{4}{75}$ per cent.

It also takes considerable time for a resistance wire so confined to reach a constant temperature, and when placed in circuit the amperes continually fall unti' the point has been reached where the heat is conducted away as fast as it is formed. In experiments which were tried by the author on wires imbedded in plaster of Paris and Portland cement, it was found that the silicates and sulphates from these substances combined with the wires at a high temperature and eventually destroyed them. The above are the main objections to the manufacture of resistance conductors inclosed in a non-conductor.

There are a number of ways in which resistance wires may be mounted; but the method most universally used is to wind the bare conductor in such lengths as required on a mandril, the spiral is then slipped off and slightly stretched to separate the different convolutions. Evidently a conductor made up in this way cannot be used at any temperature that will sensibly affect its mechanical properties of elasticity or tensile strength. Moreover, at such high temperatures oxidation is more easily effected and the conductors more rapidly deteriorate from this cause Metals brought a number of times to a high temperature and then allowed to cool, which is the practical condition when used as a variable resistance, gradually disintegrates and loses its fibrous or crystalline structure. This is especially noticeable in high resistance alloys. In addition to this the specific resistance of the conductor is increased by being raised to such high temperatures. These are the practical reasons why conductors cannot be used at more economical temperatures than the temperature they will be raised to by the current in ampères given for the different metals and diameters in Tables No. II., No. III. and No. IV. These tables have been figured from actual experiments made under practical conditions. In column No. 1 of each table is given the capacity in ampères of galvanized iron wire, tinned iron wire and german silver wire wound in spirals and mounted in wooden boxes, where fair ventilation is given. The current capacity of these wires is the maximum that should be allowed where wood or combustible material is used in construction.

A spiral loses its heat by convection much more rapidly in a horizontal than in a vertical position, and it will always be advantageous to design the resistance box so that when in use the spirals will be in a horizontal position. The box or frame in which these spirals are mounted should be open on the sides to admit free access of air.

In using columns No. 1 in the Tables Nos. II., III., IV., given are the currents which the wires will stand for one minute, and as forty seconds is ample time to start a motor under full load, the factor of safety is such that the wires would be brought only to a very dull red if by accident the starting coils were left in circuit. These capacities are only to be used with with fire-proof construction.

In column No. 1, when the wire is mounted in a wooden box, with fair ventilation the heat limit is found to be 39 degrees Cent. In column No. 2, with fire-proof construction and with slate or porcelain used as an insulator, and with free access of air, the heat limit is 48 degrees Cent., the temperature ot the surrounding air being 22 degrees Cent. In column No. 3 the temperature attained varies as the time during which the current is passing through the wire, the maximum being about 400 degrees Cent.

In the case of galvanized iron wire table, the Washburn & Moen gauge is used, and by this gauge this wire is most readily obtained in the market. The wires on which these resistances were figured is on what is known as grade B, one mill foot being equal to 92.6214 legal ohms at 15.50 degrees Cent. This wire has a resistance about 8 per cent. higher than the best grade of galvanized iron wire used in line construction. The resistance per cubic centimetre will vary from 1 to 1¼ per cent., depending upon the per cent. of carbon in the iron and the thoroughness with which the galvanizing has been done. At a temperature of about 18 degrees Cent. the resistance increases about .41 of one per cent. for each degree. If any greater degree of accuracy than 1¼ per cent. is required, a sample of the wire to be used in the construction of the resistance should be tested for its conductivity. Resistance in the tinned iron wire table was determined from ordinary tinned iron wire. The resistance of different samples may vary about 1½ per cent. from that given in the tables.

It will be noticed in comparing the different tables that different wires carrying the same ampères have all about the same resistance per foot; there is a slight difference in favor of galvanized iron wire, which may be accounted for by the zinc covering radiating more readily than the bright surfaces of tinned iron and German silver wires.

The formulæ which agree most closely with the curve plotted between ampère carrying capacity and diameters in mills to bring the wires to the temperatures given were in column 1 $c = .012d^{\frac{3}{2}}$, in column 2, $c = .014d^{\frac{3}{2}}$, and in column 3, $c = .031d^{\frac{3}{2}}$, and also in column 3 the heating effect on the wire will be found to correspond very closely with the specific heat of iron as given by Tyndall, that 2,000 foot pounds are required to raise one pound of iron from 0 to 100 degrees Cent. The high specific heat of iron is of great advantage in the case of starting shunt wound motors, as a large amount of energy disappears in raising this wire to a high temperature.

When the current carrying capacity of a wire is not considered, a wire of very small diameter can be used; then the metal whose resistance per cubic centimetre is the greatest is the cheapest resistance per ohm. When the ampère carrying capacity is taken into consideration, all this is changed.

TABLE IV.
GERMAN SILVER WIRE.

B. & S. Gauge number.	D. Diameter in mills.	D^2 Circular mills.	I. Maximum safe current in ampères.	Ohms per foot.	Feet per ohm.	Pounds per foot.
10	101.9	10381	8.5	.016640	60.9	.029858
11	90.7	8234	5.4	.020976	47.6	.023783
12	80.8	6529.9	4.6	.026448	37 8	.018860
13	72.0	5178.4	3.8	.033344	29 9	.014957
14	64.1	4106.8	3.2	.042048	23.7	.011859
15	57.1	3256.7	2.7	.053024	18.8	.009406
16	50.8	2582.9	2.3	.066864	14.9	.007456
17	45.3	2048.2	1.9	.084304	11.8	.005914
18	40.3	1624.3	1.65	.106320	9.40	.004693
19	35.3	1252.4	1.21	.137872	7.25	.003591
20	32.0	1021.5	.99	.169056	5.91	.002935
21	28 5	810.1	.88	.213168	4.69	.002327
22	25.3	642.7	.66	.268784	3.72	.001843
23	22.6	509.45	.55	.338960	2.95	.001463
24	20.1	404.01	.488	.427408	2.33	.001159
25	17.9	320.04	.434	.538944	1.85	.000921
26	15.9	254.01	.385	.679632	1 47	.000731
27	14.2	201.5	.343	.857008	1.16	.000609

TABLE II.
GALVANIZED IRON WIRE, GRADE B.

Washburn & Moen wire Gauge.	D. Diameter in mills.	D^2. Circular mills.	I. Maximum safe current in ampères in wood frames.	II Maximum safe current in ampères in iron frames.	III. Maximum safe current for one minute.	Ohms per foot.	Feet per ohm.	Pounds per foot.
3	244	59,536	55	63.8	125	.00155	645	
4	225	50,625	48	55 6	110	.00182	549	
5	207	42,849	41	47.5	90	.00216	463	.1135
6	192	36,864	30	34.8	78	.00251	398	.0973
7	177	31,329	26	30.1	67	.00296	337	.0831
8	162	26,244	23	26.6	56	.00353	283	.0695
9	148	21,904	20	23.2	46	.00423	236	.0580
10	135	18,225	17	19.7	36	.00508	196	.0483
11	120	14,400	14.5	16.2	32	.00643	155	.0383
12	105	11,025	12	13.9	22	.00840	119	.0292
13	92	8,464	10	11.6	17	.01094	91.4	.0224
14	80	6,400	8	9.28	13	.01447	69.1	.0169
15	72	5,184	6	6.96	11	.01786	56.0	.0138
16	63	3,969	5	5.8	8.9	.02333	42.8	.0110
17	54	2,916	3.7	4.29	8	.03176	31.4	.00868

TABLE III.
TINNED IRON WIRE TABLES.

B. & S. gauge. No.	Mills D.	Cu. mills D^2.	I. Maximum safe current capacity. Wood frame.	II. Maximum safe current capacity. Iron frame.	III. Maximum safe current capacity for one minute.	Ohms per foot. Legal.	Feet per ohm.	Resistance in legal ohms per 100 feet.	Lbs. per foot.
8	128.4	16509	17.4	20.3	43.6	.00308	250.	308	.040
9	114.4	13094	14.6	17.1	36 6	.00578	173.	.578	.033
10	101.8	10381	12.3	14.3	30 8	.00728	137.	.748	.02751
11	90.74	8234	10.3	12.	25.8	.009177	108.	.878	.02182
12	80.80	6529	8 7	10.1	21.7	.011571	86.4	1.198	.0173
13	71.96	5178	7.3	8.5	18.3	.014588	68.5	1.473	.01372
14	64.08	4106	6.1	7.1	15.3	.018396	54.3	1.933	.01089
15	57.06	3256	5.1	6.	12.9	.023198	43.1	2.373	.00863
16	50.82	2582	4.3	5.	10.8	.029253	34.1	3.003	.00685
17	45.25	2048	3 6	4.2	9.1	.036883	27.1	3.843	.00543
18	40.30	1624	3.0	3.5	7.6	.046515	21.4	4.924	.00430
19	35.39	1252	2.52	2.9	6 3	.060319	16.5	6.124	.00341
20	31.96	1021	2.17	2.5	5.4	.073962	13.5	7.504	.00271
21	28.46	810	1.82	2.1	4.5	.09332	10.7	9.974	.00231
22	25.34	642	1.53	1 77	3.8	.11769	8.49	12.504	.001838
23	22.57	509	1.28	1.49	3.2	.148426	6.73	16.056	.001457
24	20.10	404	1.08	1.2	2.3	.187165	5.34	19.536	.001155

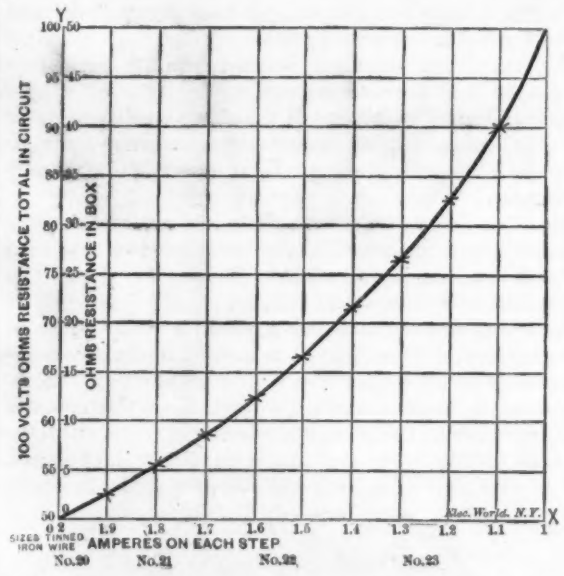


Fig. 1.—Regulation Curve between Volts and Amperes.

For instance, in German silver, tinned iron wire, and galvanized iron wire, the costs per pound bear to each other the ratio of 39, 8 and 4, but since the cost of a conductor is not merely the cost of the wire per pound, but when used as a resistance is the product of the weight, the cost, and the resistance per foot, with this in view the actual cost of the three metals used for resistance is reduced to the ratio of 20, 1.5 and 1. From the Tables I., II. and III. it can be seen that in figuring a resistance for any given drop the size of the regulator and the length of the wire used to give the required resistance will not vary with the metal of which the conductor is composed.

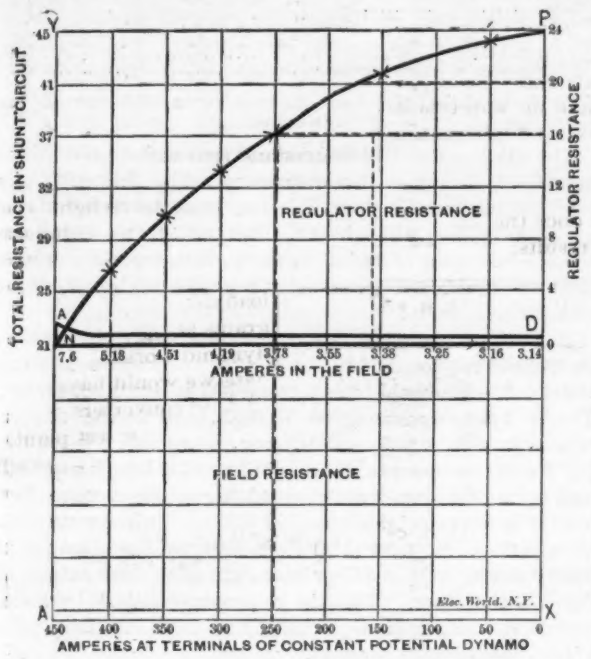


FIG. 2.—FIELD CHARACTERISTIC OF SHUNT DYNAMO.

In the German silver wire table I have only given figures representing the maximum ampères carrying capacity that would raise their temperature from 15.5 to 32 degrees Cent. This metal should only be used where very exact regulation is required, on account of its small change in resistance per degree of temperature, its high cost making its use in ordinary commercial work prohibitory.

Wires of smaller diameters than No. 22 B. & S., are not found, when wound in form of a spiral, to be stable enough when mounted to withstand the rough handling to which they are subjected in commercial work. With this in view German silver could be used in high resistance boxes with economy. Such cases could be readily determined by figuring the cost of wire in tinned iron and German silver necessary to make up the resistance required and comparing the cost of the two.

In Fig. No. 1 we have the curve between ampères and resistance which will give the least length of wire necessary to reduce the current from 2 to 1 ampère on a 100-volt circuit; this curve is the characteristic curve for any regulator figured for the maximum economy of wire and space. The abscissa *O X* may be divided off into any number of equal parts, which would be determined by the closeness with which we wish to regulate the current. These would be the different points of contact with the resistance that the sliding contact makes connection with when increasing or decreasing the resistance in circuit, or the different points of contact could be so located as to give equal volts drop or equal watts lost on the successive steps. In this arrangement, the wires are connected in series, and advantage taken of the drop in the box to reduce the size of the conductors as the ampères they are required to carry decreases. The different points along the wire, which will be determined by the resistance required on the different steps, are connected to metallic blocks over which slides a contact to which is attached one pole of the circuit, the other pole of the cicuit being taken to the contact-block, which is also connected to the first end of the resistance having the largest ampère carrying capacity, and as the contact arm is moved away from the first contact block more resistance is thrown in circuit.

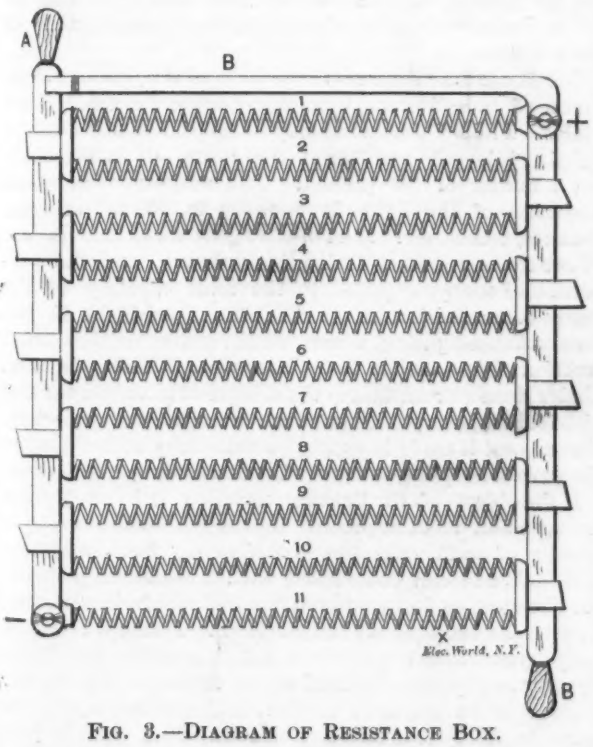


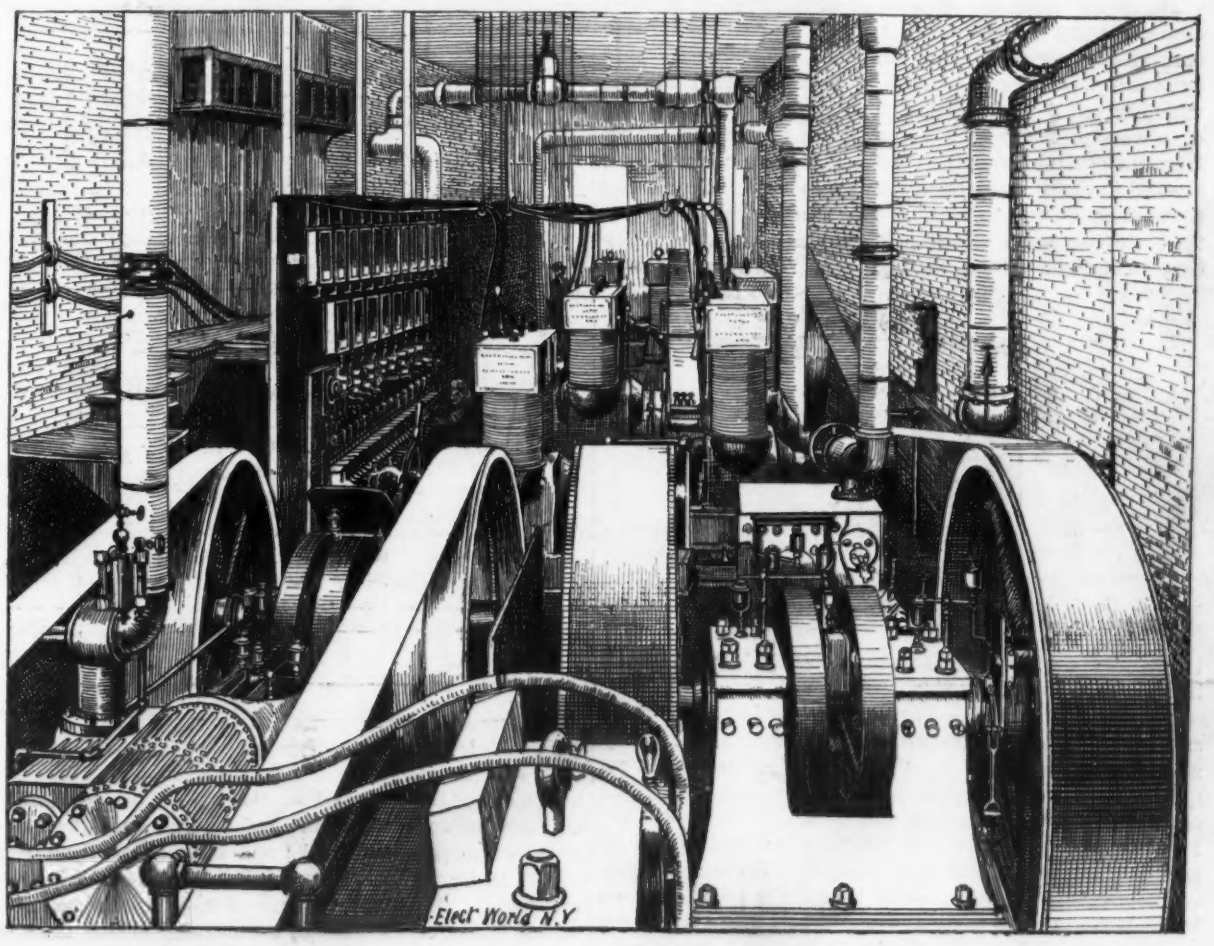
FIG. 3.—DIAGRAM OF RESISTANCE BOX.

Very often it is required to figure a resistance box that will adjust resistances to suit special conditions which will arise in the circuit to be controlled by a regulator, for instance, in the case in which we wish to determine a regulator for a constant potential shunt wound dynamo, where we want to produce an increase of load proportional to the distance through which we move the contact arm. This can readily be determined from the field characteristic of the dynamo such as shown in Fig. 2.; the abcissa *A X* can be divided off proportionally from no load to full load at a constant potential and the ordinates *A Y* laid off proportionally to the total resistance required in the shunt circuit, which will be the resistance of the field plus the additional resistance required to produce the ampères at the terminals of the dynamo. Several such points may be determined between the maximum resistance and no resistance. Laying off ordinates proportional to the resistance required in series with the field resistance, draw a curve through these points. If the line *NO* is divided off into a number of equal parts corresponding to the number of steps or contact points which we wish in the regulator, the ordinates from these points will be proportional to the resistance required on the different steps to give a regulator, which will give an increase of load directly proportional to the number of contact blocks in circuit. If the dynamo is kept at a constant potential the line *AD* is the increase of resistance of the field on account of its heating. If the area between *AD ON* is small enough to be neglected in comparing with the area *AN OX*, then the resistance box or a constant potential shunt wound dynamo could be used instead of an ampère meter by numbering the blocks consecutively; the output at the terminals of the dynamo will be the number of blocks out of circuit multiplied by a constant. Proceeding in the same way, a regulator can be figured to suit any required conditions.

There is another large class of regulators, such as equalizers, stage regulators and storage battery regulators, where, to accommodate the ampère capacity required, it will be found necessary to strand the resistance wires when we have to deal with large currents. Since the resistance per foot decreases as the ampères capacity increases, we soon find that the space and wire required to give a large current any considerable drop would make the regulator bulky, heavy and expensive, if the wires were connected in series. Methods of compounding or special combinations of the resistance wires can be resorted to with advantage. The expense incurred in constructing such mechanisms to distribute the current in various ways through the resistance wires will be offset by the decrease in the size and weight of the regulator or equalizer.

A number of methods are used by different manufacturers; in Fig. 3 is illustrated the general method by which economy in wire is effected, by means of special switches to distribute the current through the resistance conductors. When the lever *A* is in the position shown in Fig. 3, the resistance coils are short-circuited from the positive pole through the metallic bar *B*, and then through lever *A* to the negative pole, when the lever *A* is withdrawn from contact. With bar *B* all the resistance coils are then in multiple arc between the positive and negative poles. In this position we have the maximum ampère carrying capacity and the least resistance.

The resistance is increased by still further withdrawing the bar *A*, when the coils 1 and 2 will be cut out and the resistance of the regulator increased. The resistance can be still further increased by steps until lever *A*, in sucession, is withdrawn from all the contacts, when we will have only spiral No. 11 in circuit. The resistance may then be increased by withdrawing lever *B*, and the spirals placed in series. By this arrangement we have obtained a regulator having the maximum ampère capacity on the first step, with all the spirals in multiple, and a maximum resistance on the last step, with all spirals in series; if the resistance of spiral 11 is so proportioned that it will not take more current than the maximum when lever *A* is removed, all the rest of the regulator will have ample capacity. This form of regulator can be figured to any curve by making the spirals of unequal resistances. Such a combination only gives 12 possible steps, but a more complicated switch could be designed which would multiple series the spirals, and which would give us a greater number of combinations with these spirals, so that any desired number of steps could be produced between the maximum ampère capacity and maximum resistance. In any regulator energy must be wasted to produce certain variations in the current. From the point of economy they are abominable, but they are as necessary to the electrician as the valve is to the engineer.



THE EDISON ELECTRIC ILLUMINATING COMPANY'S PEARL STREET STATION, NEW YORK.

The Reconstructed Pearl Street Station.

We present herewith a cut of the reconstructed dynamo room of the Edison Company in Pearl street. As will be readily seen, vastly less space is taken up by the new plant than by the old. The upper stories of the building are stil undergoing reconstruction. The plant in operation consists of four No. 2 Edison dynamos, having a normal capacity of 1,400 lamps each. Four No. 20 Edison dynamos, 850 lamps capacity each, and one of the old Jumbo dynamos, coupled direct to a 150 h. p. Armington & Sims engine and having a capacity of 1,500 lights. Much of the saving in space has been due to the substitution of the new machines in place of the old Jumbo dynamos previously in use in this station. Of these machines, the one now in use was the only survivor of the fire, and yet was so injured as to have to undergo repairs almost equivalent to reconstruction. The engine which operates this dynamo is the only old engine in the reconstructed plant, the other engines being one Armington & Sims Engine, 200 h. p.; one New York Safety Engine, 200 h. p., and two of the same make, but of 150 h. p. capacity each. The plant arranged as shown in the cut is a decided improvement over the plant that was destroyed, and the engineers of the station are to be congratulated on the rapid and successful working by which the plant has been put into full operation.

Some Tests on the Efficiency of Alternating Current Apparatus.*

BY DR. LOUIS DUNCAN AND W. F. C. HASSON.

Several papers have appeared lately on the efficiency of alternating current transformers, some of which have been of a more or less theoretical nature, while others have given the results of actual tests. I have never, however, seen any tests on alternating current dynamos, excepting the experiments made by Dr. Hopkinson and Professor Adams on a de Meritens machine used for lighthouse work. Even the converter tests have given such varying results that one can hardly be certain as to the real efficiency.

The introduction of the alternating system has been so rapid and is so rapidly increasing that people are apparently well enough pleased with the results not to bother about the smaller question of the reasons for them. But whatever the results may be, it is of value to know just where the losses in any system may come in, so that we may seek how to avoid them; if we are succeeding, it may enable us to increase the profits; if we are losing, it may help us to avoid further loss.

This apparatus, the measurement of which is the main subject of this paper, consisted of a Westinghouse 750-light No. 1 dynamo, with a No. 2 exciter and an outfit of 40-light converters. This apparatus had been presented by the Westinghouse Electric Company to the Johns Hopkins University, and was tested a couple of months ago. The workmanship of the machines is excellent.

The plant consisted of a 75 h. p. Armington & Sims engine driving the dynamo and exciter through a Tatham transmission dynamometer. Engine, dynamometer and dynamos were firmly secured to heavy parallel timbers which served as a foundation. The converters were banked on a wooden framework at a distance of some 30 yards from the dynamo, and their primaries were permanently secured to the dynamo circuit, a switch in the latter serving to cut them off when desired. The ammeter belonging to the plant was put in this circuit and was read when efficiency measurements were being taken. The secondaries of

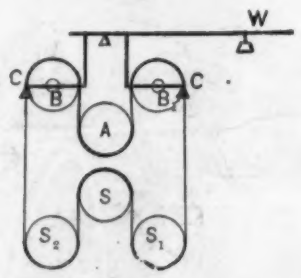


Fig. 1.—Diagram of Tatham Dynamometer.

the converters were taken to a switch-board and then to incandescent lamps mounted on racks.

Power measurements.—The Armington & Sims' engine supplying the power, worked regularly and satisfactorily and the governor could be adjusted to give the speed required at the dynamo. The Tatham dynamometer was the one used for power measurements at the International Electrical Exhibition, held in Philadelphia in 1884, where its accuracy was checked by making with it a determination of the mechanical equivalent of heat. The result obtained in the latter measurement was 772.8 foot pounds per degree Fahr., and show that the dynamometer is practically accurate. A description of the experiments and of the instrument may be found in the report of the test made to the Franklin Institute, but it will not be out of place to briefly describe the apparatus here.

An endless belt, as shown in figure 1, passes over the driven pulley, S, to the shaft of which the engine is belted, round the pulleys S_2 and B, to the driving pulley A, and back over B_1 and S_1 to S again. The bearings of the pulleys B and B_1 are in cradles pivoted on knife edges, C, at their outer ends, and at the inner ends are connected by links at equal distances on the two sides of a knife edge which supports the scale beam W. The outer side belt passes through the line of the knife edges, C, and therefore has no effect on the scale beam, but the tensions of the inner parts of the belt act directly on the scale beam, and as they are on opposite sides of the fulcrum they act against one another. The beam is so graduated that this difference of tension is read off directly in pounds, and this quantity—the difference of tension of the belt on the two sides of A—multiplied by its circumference and speed, give the horse-power delivered. A weight travels on the beam W, and readings can be taken with great accuracy.

Electrical Measurements.—The energy in the secondary circuit was measured by means of a Cardew voltmeter and a Thompson ampère balance. As it is not the custom to put a number of secondaries in parallel, each converter had its separate lamp circuit.

Before making an efficiency test, the potential difference in the primary was regulated—there being a Cardew voltmeter in that circuit, and a separate measurement of the potential difference and current in each secondary circuit was made. When the test was actually in progress the voltmeter and ampère balance were used in one of the circuits, and the currents and P. D.'s in the others were calculated from the readings in this circuit together with the previous measurements. Both the voltmeter and ampère balance were accurately calibrated, the former being checked after each test, while the latter had its constant determined with both continuous and alternating currents. The P. D. at the terminals of a non-inductive German silver resistance in circuit with the balance was observed, when a continuous current was flowing, and also with an alternating current of the same period as that employed in the test. The current in each case was calculated from the resistance and P. D., and the results gave no appreciable difference in the constant for continuous and alternating currents.

The following table shows at once the order in which the tests were carried out and the results:

HORSE-POWER ABSORBED AT VARYING E. M. F.'S.

	E. M. F.		H. P.
	Dynamo	Exciter.	
Horse-power for exciter, field not made	0	0	.34
" " field made	0	110	.75
" " dynamo alone	0	0	2.73
" " dynamo and exciter	0	0	3.04
" " " " "	0	107	3.51
" " " " "	1,376	124	12.5
" " " " "	1,168	104	10.1
" " " " "	1,099	105	9.60
" " " " "	1,040	105	9.0
" " prim's of conv's on	1,216	105	12.0
" " " " " "	1,171	104	11.8
" " " " " "	1,107	104	11.12
" " " " " "	1,048	104	10 64

TABLE OF EFFICIENCY OF VARYING LOADS.

Approximate load.	Exciter. F. M. F.	Exciter. Current.	Dynamo primary E. M. F.	Dynamo primary Current.	Converters E. M. F.	Converters Current.	Horse-power in lamp circuit.	Mechanical horse-power.	Loss in horse-power.	Efficiency.
¼	105	9.4	1,107	10.	49.5	153.9	10.21	21.83	11.62	46.8%
½	104	10.5	1,107	18.9	49.6	338.4	22.50	34.4	11.90	65.4%
¾	101	11.	1,113	28.6	50.0	520.7	34.9	48.0	13.1	72.7%
Full	112	11.5	1,123	38.1	50.9	739.8	50.48	64.44	13.96	78.3%

EFFICIENCY OF CONVERTERS.

No. 8. 40-light converter.

No. of lamps.	Volts.	Watts in secondary.	Loss in watts.	Loss in iron.	Efficiency.
40	50.0	2,001	109	....	94.8
0	50.9	0	84	84	....

No. 4. 20-light converter.

No. of lamps.	Volts.	Watts in secondary.	Loss in watts in secondary.	Loss in iron, watts.	Efficiency.
20	48.8	952	106.	95 2	90.0%
15	52.2	817	114.8	108.9	87.6%
10	50.3	506	101.7	99 2	83.3%
5	51.44	264	109.4	108.7	70 7%
0	52.3	0	110.5	110.5	0. %

The efficiency of the converters was measured by placing them in a metal calorimeter, between the double walls of which water was allowed to flow. The temperatures of exit and entrance were observed, as well as the weight of water which passed through; at the same time the current and P. D. in the secondary circuit of the converter were measured. A separate observation gave the radiation, which was of course allowed for although it was made as small as possible. A number of converters were experimented on, but I give but two of them—a 40-lighter, such as was used in the tests, and a 20-light converter, which was very carefully tested by two of my students, Messrs. Bliss & McKeen. In the latter case, the observations were made at slightly different P. D.'s, and the results show that the loss in the iron varies as we would expect it to vary—that is, very nearly as the square of the voltage. The variation will not be exact, as the losses due to the reversal of magnetism do not vary quite as fast as the square of the induction.

I would like here to call attention to the fact that in an excellent paper read before this Institute, Professor Ryan, of Cornell, found that the losses in the iron of a 10-light converter decreased greatly as the load increased. This was accounted for by the fact that there was a jar (evidenced by the singing of the converter) at the higher loads, due to the attractions of the secondary and primary coils. While it is true that the losses in the cores of very small converters are not exactly constant, yet they are nearly so, and a large part of the decrease found by Professor Ryan is due to the voltage being greater at the low than at the high loads.

Looking now at the figures given in the tables, we are struck by two things: the very large amount of power absorbed in the core of the armature, and the very small loss in the converters on open circuit. The dynamo losses due to reversals of magnetism and eddy currents at the E. M. F. used in the test are no less than 6 h. p., while the energy due to reversal of magnetism and eddy currents in the 16 converters is only 1.6 h. p. Another rather striking thing is the almost constant ratio of primary and secondary currents over a considerable range. The maximum efficiency is about 78 per cent. It would seem that the losses could be divided into a constant part, and one varying with the currents, but this is not true with the older style and smaller converters of the Westinghouse company.

Suppose we have a plant such as is described above, and use it for commercial lighting. Taking data from one of the local companies employed in supplying incandescent lights on this system we have, for two 2,500 light dynamos, the following outfit of converters:

Size of Converters.	Capacity.	Number in use.	Total Lamps.
No. 1	5 16 c. p. lamps.	44	220
No. 2	10 " "	61	610
No. 4	20 " "	43	860
No. 6	30 " "	49	1,470
No. 8	40 " "	64	2,560
Total lamp capacity			5,720
Number of lamps supplied			4,557

I understand that the converters being added are of the larger sizes.

The efficiency of the 30-light converters does not differ greatly from that of the 40-lighters. The following is a load diagram of this plant, selected from a number of diagrams as giving a fair average curve. If we have our dynamo working to its full capacity, then from the above data we would have a converter capacity of twenty-three 40-light converters.

If, as in our test plant, these converters are 40-lighters, or 30-lighters—for the efficiency of these two sizes is about the same—we would have a mean loss in our plant of, say, 10 h. p. in our dynamos ($9\,6 + C^2 R$), and in the converters about 3 h. p. ($2.3 + C^2 R$); or all together about 13 h. p. From the above table we will have 750 lamps supplied, and taking the data from the load curve, the average load would be in the neighborhood of 1,300. This corresponds to about 20 h. p., and the efficiency of the plant for 24 hours would be $\frac{20}{24} = 64$ per cent., minus the percentage of loss on the lines. This, in a properly installed system, should not average two per cent., so that the final efficiency would be 59 per cent.

A continuous current dynamo supplying the same outfit of lamps, with a maximum loss in the mains of, say, 15 per cent., would have a greater average efficiency. But I wish to point out that the maximum efficiency of the two

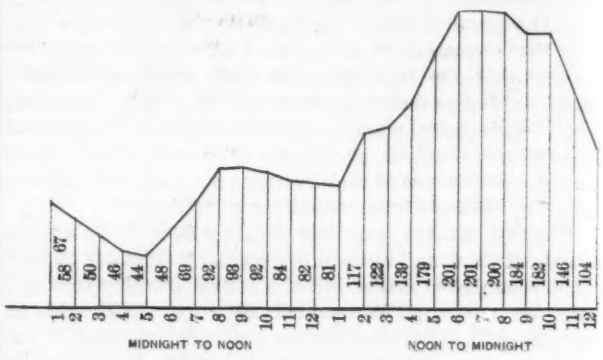


Fig. 2.—Load Diagram.

plants would be about the same, so that they would require the same capacity of station outfit, boilers, engines, dynamos, etc. When more than one dynamo is provided the efficiency is increased by using only one of them during the times of minimum supply, and always working as far as possible only a little below the maximum capacity of the machines.

Let us consider these results in view of the present condition of incandescent light distribution in the United States. I take it that what may be called domestic electric lighting is largely a matter of the future—it is certainly not a matter of the present. The majority—the great majority—of the lights in use are in shops, saloons, theatres, offices, etc. Most of the lights wired are in use at one time or another during the 24 hours, and the proportion of energy supplied to the total capacity of the lamps connected is much greater than it would be in the case of house lighting, where, on the average, only a small fraction of the possible lamp hours are actually in use. Under these circumstances the scheme of alternate current distribution is very different from what it will be when the attempt is made to supply an entire city with light, as they are attempting to supply London at the present time.

If the object of the lighting company is to supply the demand that exists at present, then a system employing a number of small converters is preferable. Such a system is flexible and can be installed with a minimum expense for the more or less scattered demand which is presented in even the most closely settled town. I take it that this is the great difference between the alternating and direct systems as at present installed in this country. The former skims over an extended district, taking advantage of its great flexibility to absorb any business which can be got; while the latter settles itself in a densely-buiit centre, installs a larger plant than is primarily demanded, and works up a business within the limits of economical distribution. Therefore, it is hardly right to compare the present systems of direct and alternating supply, as the latter has not been reduced to a point where entire districts are to be supplied.

To show the disadvantage of the present system for domestic supply, suppose we have an ordinary house, such as one of us would live in; it would be necessary to have a converter of at least 20-light capacity. The constant loss is, say, 100 watts; so, leaving out the $C^2 R$ loss, we would have a total loss in 24 hours, of $\frac{2400}{746}$, or about 3 h. p. hours, corresponding to, say, 45 lamp hours. Taking my own experience the actual number of lamp hours used

*A paper read before the American Institute of Electrical Engineers, March 18, 1890.

is about 30 lamp hours during 24 hours, so the efficiency of the converter would be something like $\frac{1}{3}\frac{0}{0} = 40$ per cent. It is evident that unless the losses in converters can be greatly decreased, a house-to-house distribution with a converter in each house would hardly pay.

It would seem, then, that if gas is to be really displaced and serious competition with it is to be attempted a different system of distribution must be worked out. We must replace the numerous small converters with one large converter supplying a comparatively extended district, thus decreasing the converter capacity, since the law of average can be taken advantage of, and greatly increasing the efficiency. If an extended secondary network is employed some of the converters may be disconnected from the mains at the turn of minimum demand.

Let us inquire for a moment how the increase in the capacity of converters will modify the designs with which we are familiar. In the first place, if we increase the linear dimensions of any type, since the radiating surface only increases as the square while the volume increases as the cube of the dimension, then we cannot suffer the same loss per cubic centimeter of the iron for the large as for the small sizes. We must decrease the intensity of magnetization or we must decrease the periodicity.

Let us take a typical case. Suppose we have a transformer and double all of its dimensions. If we employ the same induction we will need but one quarter the number of turns in the coils, and as the cross-section of the space occupied by the wire is four times as great, the area of the wire may be sixteen times as much. As the length is twice as great, the resistance in this case is one-eighth. But the losses in the iron are, roughly, eight times as great; this we cannot allow, since the radiating surface is but four times as great: hence we must diminish the induction. In fact, we must so arrange things that the loss in the larger converter is only four times that in the smaller, in order to work at the same temperature. As at the low induction used the loss due to hysteresis varies nearly as the square of the induction we may take it roughly that the large converter should have an induction of three-quarters of the smaller one. This will modify our figures. Instead of one-quarter the number of turns we will have one-third, and the resistance of the coils will be one-sixth instead of one-eighth, as we can allow four times the loss that we suffered before we can have, roughly, five times the output.

As a total result we have five times the output with four times the loss, or, as the $C^2 R$ effect is not important as compared with the other losses, we can have six times the output with the same fall of potential in the secondary. That is, the efficiency of the larger converters will be greater than the smaller ones of the same design, and working at the same temperature, but the output per pound of metal will be less.

Suppose when we increase the size we decrease the number of reversals. Take a case, for instance, in which the dimensions are doubled while the reversals are halved the maximum induction remaining the same. We could have half the turns in the coils, and as they occupy four times the space and are twice as long the total resistance would be one-quarter, and for the same heating effect we would have four times the output.

If we take losses by eddy currents into account there will be a constant per cubic centimeter, provided the period and maximum induction are constant and the thickness of the plates is unchanged; otherwise they will vary as the square of the induction, with a constant frequency, or inversely as the square of the period, with a constant maximum induction. This, in practice, would make the values of the output for the larger currents given above somewhat greater. What I wish to show, however, is that we are limited by heating considerations and considerations of fall of potential in our secondary in the output of large converters. If we consider the properties of the materials of which converters are made, we would, I think, find it most economical to make converters that reach the temperature limit, except for the very smallest sizes.

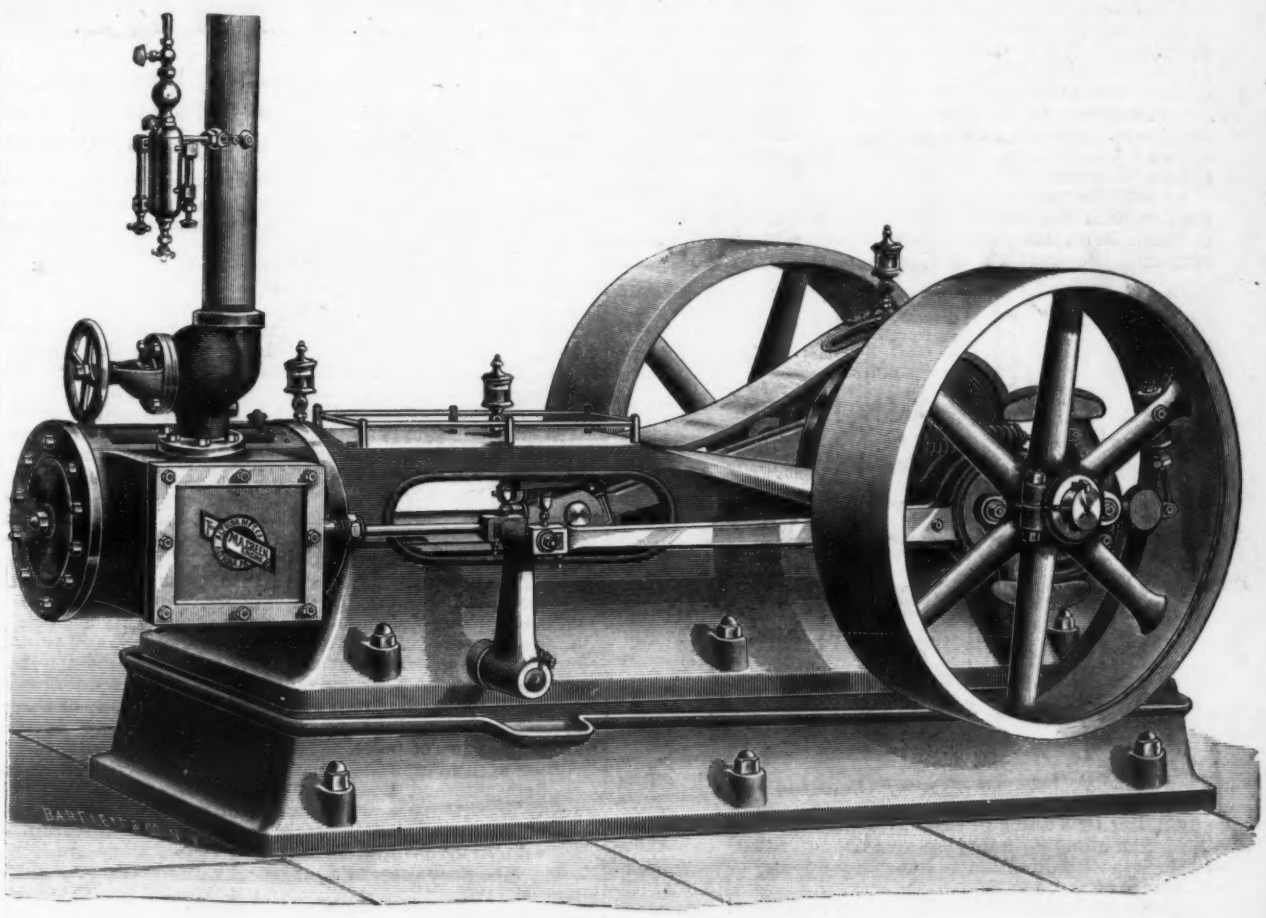
Many of us have, I suppose, read Mr. James Swinburne's paper, read before the British Association at Newcastle last year, on the "Design of Converters," and have been struck by the fact that almost all of the converter dimensions given by him are impracticable, either on account of the disproportionate heating of the larger sizes, or the excessive fall of potential in the secondary. In increasing the size of dynamos we usually increase the output per pound weight, but there is the vital distinction between dynamos and converters that losses occur through the entire mass of the latter, and as we increase the volume we increase the losses in the same proportion. In the dynamo, on the contrary, there are practically no losses in the heaviest part of the apparatus, *i. e.*, the field magnets. As a result, while we gain in efficiency in the larger sizes, yet we must decrease either our induction or the rate of reversal, and the output per pound is not increased.

In the discussion that followed Dr. Duncan's paper given above Messrs. Tesla, H. Ward Leonard and Wheeler took a prominent part. Mr. Tesla called attention to the fact that a certain amount of the inefficiency of an alternating dynamo found by Dr. Duncan was due to the necessity of working with a highly saturated field in order to obtain a constant potential on the converters. He further was of the opinion that the system tested by Dr. Duncan was not of the very latest model; that more recent dynamos and converters would give more satisfactory results for the alternating system. He advances the idea that in making larger converters, to which Dr. Duncan alluded in his paper, it would be desirable to keep a constant length of magnetic circuit. To this Dr. Duncan responded that such a construction would not give the best results, and that to build a large converter would require a departure from the proportions employed in smaller converters both in copper and iron. He was of the opinion that the losses in the converters, especially for the larger sizes, could be decidedly decreased.

Mr. Leonard took up the discussion from the standpoint of a continuous current electrician, and pointed out that Dr. Duncan's result gives a lower efficiency to alternating currents than had previously been supposed. He further spoke of the disastrous effects of a small average load on efficiency, mentioning one case where in quite a large plant the average load for twenty-four hours is only 12 per cent. of the maximum load. This, of course, would bring into very forcible action the efficiency of devices such as converters, which are lowered in efficiency under a light load.

Dr. Wheeler took part in the discussion in order to give a very clear and interesting account of a case of interference between contiguous alternating circuits which had come under his notice the result being a periodic flickering of the lights, which was entirely obviated by changing the position of the circuits.

Mr. Frederick Darlington advanced a practical point in claiming that the alternating system, with its use of only 50 volts potential, made it possible to use a more economical and durable lamp than can be employed with the higher voltages. In the case of the company he represented in the city, the average load was 23 per cent. of the maximum. Taking everything into consideration, he was of the opinion that the real efficiency of the alternating system of lighting was greater than appeared from Dr. Duncan's figures.



A NEW ENGINE FOR ELECTRIC LIGHT WORK.

A New Electric Light Engine.

The severe conditions of electric lighting have served as a great stimulus to steam-engine designers, and the result is shown in engines like the one illustrated herewith. It was designed by Mr. M. A. Green, and is built by the Altoona Manufacturing Company. The governor has been the subject of special care, and the results attained in the regulation have been of an extremely satisfactory character.

The working parts are mainly of solid forged steel, and no trouble has been spared to make a durable and efficient machine. It is an engine of the double crank type, and, as will be seen from the cut, is singularly compact in form, occupying comparatively little floor space, and at the same time being simple and strong. The valve is a balanced slide valve taking steam on the inside; the piston is hollow to reduce weight, and is packed with spring rings. A brief description of this new engine was given in last issue, but inadvertently was connected with a cut of quite a different engine.

Some Points in Dynamo and Motor Design.*

(*Continued from page 227.*)

7. POSITION OF THE BRUSHES IN DYNAMOS AND MOTORS.

If dynamos are to run sparklessly there must be a lead given to the brushes, or, in other words, the point of collection must be advanced in the direction of motion until the field passing through the commutated sections is just of sufficient strength to stop the current, reverse it, and bring it to its normal strength in the opposite direction before the section leaves the brush. When a section is short-circuited under the brush, any lines of force which were induced, due to the current flowing in it, are annihilated, the current tending by self-induction to continue in the same direction round the short circuit. As the section leaves the brush a current has to be started in it in the opposite direction, and the self-induced E. M. F. opposes this also, thus tending to prevent both the stopping and the starting of the current.

The E. M. F. of self-induction depends, obviously, upon the variation in the number of lines through the section which the cessation of the current is capable of producing, on the speed of the armature, and on the number of turns per section. When an armature core is saturated to 17,000 lines per square centimetre, it will be realized that the variation in the lines through the section which the short-circuiting is capable of producing is very small; in fact, we may say that it is practically negligible. But, with the smallest amount of self-induction present, it takes a certain time to effect these changes in the section, and the brush must be of such thickness that the changes are effected before the short-circuit is removed. The brush must be placed in advance of the neutral point; in an armature, for instance, having 50 sections, presuming that 5 volts are wasted in the armature, a section when it leaves the brush must move in a field having such strength as will neutralize the effect of self-induction, and give one fifth of a volt over. If the armature has 100 sections, the field must give a resultant of one-tenth of a volt; but the E. M. F. due to self-induction will be in the latter case only one-fourth of what it was in the former. By saturating the core, and making the sections sufficiently numerous, we can make the self-induction as small as we please; and in machines in which the current varies from 0 to a maximum, we purposely make it as small as possible. The reason is, that as the current increases, the variation in the E.M.F. of self-induction does not correspond with the variation in the shape of the field for different positions of the brushes, perfect adjustment for all currents being therefore difficult. By making the self-induction very small we get a close approximation to perfect adjustment; we can place the brushes very little in advance of the zero position, reducing in this way the adjustment for variation in the current to a minimum.

We see, then, that in a dynamo the brushes must be set in advance of the neutral point, and that self-induction increases the lead. Is the trail in a motor similarly increased? The answer is that it is. The brushes must be set in a motor behind the neutral position, so that the induced E. M. F. is in the same direction as the current to be started in the section, and so that the E. M. F. of self-induction which opposes the starting is neutralized. It appears that the best position for the brushes in a motor is the position in which they have about the same trail as they have lead when the machine works as a dynamo, and that in a motor the trail is *increased* by self-induction.

8.—THE LOAD TO BE CARRIED BY ARMATURES.

Assuming that a machine is properly designed, a position can be found for the brushes where the sparking is *nil*. If, on the other hand, the machine is badly designed, or if the current carried by the armature is too great, a sparkless collection will be found imposible from the excessive distortion produced by the armature field. There is for every machine a certain limiting number of ampère turns which the armature can carry beyond which we cannot go without effecting some radical alteration in the design.

* A paper read by W. B. Esson, Member, before the Institution of Electrical Engineers, Feb. 20, 1890.

Now it is manifestly of the very greatest importance to know to what extent an armature can be loaded for a given field. It will be understood that the cross induction—that is, the lines of force which can be induced by the armature winding—depends upon the number of ampère turns on the armature, and upon the magnetic resistances of the various parts which make up the cross circuit. Undoubtedly the induction follows the same law for the cross as for the forward circuit, though it is difficult to determine with accuracy either its magnitude or direction. But we know that by far the largest portion of the resistance is encountered in the air gap, and that increasing the length of the gap diminishes almost in inverse ratio the cross induction. We know also that the cross induction depends on the width of the air gap, for the greater the cross section of the gap, the greater the cross induction for a given cross section of armature core and a given magnetizing force. It depends also, but to a less extent, on the induction in the core.

The forward induction we can give to a machine may be considered as proportional to the cross section of the armature core; for if the magnets are large enough, with sufficient magnetizing force, we can always in normal types get an induction of 16,000 to 17,000 C. G. S. per square centimetre.

Now the distortion of the field depends upon the ratio of the cross to the forward induction. In actual machines we have not, of course, two sets of lines crossing each other, but the tendency to produce a cross induction is manifested in a distortion produced in the forward lines. It is to prevent the sparking which would ensue, due to this distortion, that a lead is given.

The cross induction may be reduced in double-magnet machines by thinning down the magnets as shown in Fig. 3. This illustrates a type of magnet I designed in 1884, which gave first-class results, to the great surprise of many who believed that no good effects could be obtained without massive pole pieces, irrespective of the configuration of the magnetic circuit otherwise. For the reasons given in Section 3, it is undesirable to reduce the section of single magnet machines with this object. Another plan for reducing cross induction is in making the air gap increase from the crown of the poles toward the tips, as was done by Messrs. Paterson and Cooper in the Lumley machines before I joined them, and as is done in some of the Manchester machines for another purpose.

As both forward and cross induction are proportional to the length of the armature, we need not consider that dimension here, but simply confine ourselves to the cross section of the armature and poles as shown by the several

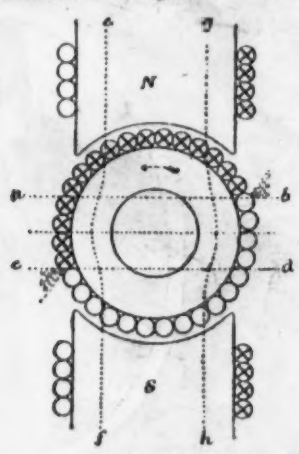


Fig. 19.

drawings. A lead being given to the brushes, it will be observed that the convolutions lying between the two horizontal lines $a\ b$ and $c\ d$, Fig 19, directly oppose the forward induction along $e\ f$ and $g\ h$, since the current flows in them in the opposite direction to the current round the magnets. The lines of force which would be sent in an opposite direction may be called the backward induction. This, *per se*, is of little consequence, as it can be compensated by additional turns on the magnets, but the distortion of the field to which its existence is due, is of enormous importance.

It is not my intention to take up time with any calculations respecting the actual number of crosslines which would be induced by the current flowing in the armature, or to try and map out the exact distribution of the field as modified by cross induction. For the present I will be content with the statement—which is, of course open to criticism—that, roughly the cross induction is proportional to the ampère-turns on the armature and to the width of the poles, measured parallel to the direction of rotation, and inversely proportional to the length of the air-gap, *i. e.*, the distance between the polar surface and the surface of the armature core. Calling A_2 the ampère turns on the armature, w the width of the air gap, and l its length, the tendency to induce cross lines is measured by $\frac{A_2\ w}{l}$; and since the forward induction is proportional to the radial depth of the core r for all sizes of machines, the ratio between the above value and r should be similar. In other words, the ampère turns which can be carried by the armature are proportional to the radial depth of the core and to the length of the air gap, and inversely as the width of the pole: whence

$$A_2 \propto \frac{r\,l}{w}$$

For the purpose of showing to what extent some such relation as exhibited obtains in the machines now made, I have given in Table II. the dimensions of several taken at random. In the first column, after the names of the dynamos, comes the outside diameter of the armature core, which does not enter into our expression. Next come the ampère turns carried, followed by the radial depth in centimetres, with both of which we have to do. In column IV. is given the angle in degrees embraced by each pole, while columns V. and VI. give the length of the air gap and width of the pole. In column VII. is given a coefficient by which the right-hand side of the equation must be multiplied, in order that for the sign of proportionality we can in each case substitute equality. According to the proposition put forward this coefficient ought to have the same value in all cases. The agreement is marvelous when we remember that in machines of the same size we have to vary the load considerably to suit different outputs, and that in the examples given the saturation may vary considerably. The disturbance due to cross induction bears about the same proportion in all; the similarity in this respect being, in fact, remarkable for machines so dissimilar otherwise. The machines Nos. 7 and 9 have iron wire cores, but Mr. Kapp has kindly given me the equivalent dimension of the radial depth were plates employed instead, and this is what appears in column III. The machine No. 4 is given because it is the one which departs most from my equation. The ampère turns on the armature are here so few—that is to say, there is so little copper and so much iron—that I at one time suspected it of being the very machine which Mr. Crompton confesses to having designed during Mr. Kapp's absence at Vienna.* In the machine No. 8 the coefficient has been since reduced by narrowing the poles. About the motors Nos. 13, 14 and 15 I shall have something to say presently. In these the edges of the poles are curved along their lengths, hence the two angles in column IV. The coefficient is calculated from the mean width.

TABLE II.—LOADS CARRIED BY CYLINDER ARMATURES.

Name of Machine.	I. Outside diam. of arm. core.	II. Ampère turns on the armature.	II. Radial depth of the core.	IV. Angle embraced by each pole.	V. Length of the air gap.	VI. Width of the pole piece.	VII. Coefficient.
				deg.			
DYNAMOS.							
1. Gramme	18.3	6,000	2.65	135	0.85	23.0	61,265
2. Phœnix	22.2	6,500	2.85	115	0.80	24.0	68,421
3. Phœnix	27.0	9,000	3.35	112	0.96	28.5	79,757
4. Crompton	18.3	7,560	3.80	135	0.96	23.5	48,700
5. Manchester	2 41	10,500	5 05	139	0.80	31.0	80,569
6. Phœnix	33.0	13,500	5.10	115	1.10	35.5	85,427
7. Kapp	33 0	13,020	5 30	140	1.25	43.0	84,507
8. Phœnix	35.5	18,000	6.35	122	1.20	40.6	95,905
9. Kapp	36.8	13,875	6.10	140	1.25	48.0	87,344
10. Crompton	39.35	26,400	7.94	135	1.95	51.0	86,959
11. Phœnix	43.0	23,000	8.90	115	1.27	44.2	89,940
12. Phœnix	4.56	17,100	7.30	120	1.27	47.0	86,689
MOTORS.							
13. Immisch	30.4	9,000	6.40	120 / 130	0.96	3.52	51,562
14. Immisch	38.0	15,000	7.60	120 / 130	0.96	43.5	89,432
15. Immisch	61.0	27,300	11.40	120 / 130	1.63	70.0	102,840

Inserting what appears to be the mean value in column VII., we have for the ampère turns which may be carried by an armature the expression.

$$A_2 = \frac{rl\ 85{,}000}{w},$$

which may prove very useful until we get something more exact. We have been taught by experience that diminishing the ampère turns, increasing the radial depth, increasing the air gap, or diminishing the width of the poles, reduces the distortion and cures its attendant evil of sparking. The equation states the same thing in another way, for it tells us that the ampère turns may be increased in proportion to the radial depth and to the length of the air-gap, and inversely as the width of the poles. I do not wish for a moment to dogmatize on this subject. It is not pretended that the expression is complete, as there are doubtless many factors upon which the load depends. Among these are, obviously, the number of sections of the armature, the shaping of the pole-pieces, and the general configuration of the magnetic circuit. But the equation is at least a guide, and if the coefficient 85,000 is not exceeded, the machine can certainly be made to run without sparking. The expression applies equally to armatures with more than two poles, only in the case of these the ampère turns given by it must be multiplied by the number of pairs of poles.

When speaking of the radial depth being increased, it is of course assumed that there is the same induction per square centimetre in the increased section of the core. Again, increasing the air gap is not supposed to diminish the induction, as additional magnetizing force must be provided to keep it up to its original value. We conclude, then, that if the output of a machine of given carcass dimensions is to be increased—or, in other words, if the ampère turns on the armature are to be greater—the tendency to increase cross induction must be counteracted by increasing the resistance of the air gap. Some will doubtless be astonished to hear that greater output necessitates increased magnetic resistance.

Mr. Ravenshaw has a rule to the effect that in order to prevent sparking in cylinder armatures the ampère turns must not exceed 35 times the total area of the core in centimetres, or in drum armatures, assuming the same induction per square centimetre, 70 times the area. The rule has been applied to the construction of several types of two and four pole machines, but it does not seem to me universally applicable, since the number of ampère turns allowable depends not only on the area, but on the relation of the two factors which make up the area.

Practical men must have rules of some kind. Without them their practice would not be continued for a single day. These rules, written or unwritten, are the results of experience which have been aggregated into some kind of applicable shape, but justification for which it would often be difficult to find on purely scientific grounds. We have to make our rules as we go along, engineering tuition and empiricism leading the way, knowledge and scientific accuracy following. We can speak with authority regarding the utility of a formula which we would be ill prepared to justify scientifically. It is because the rule here given has proved useful to me that I venture to suggest its use to others.

TABLE III.—LOADS CARRIED BY DRUM ARMATURES.

	Name of Machine.	Diameter of Armature Core in cms.	Ampère turns on Armature.
	DYNAMOS.		
1	Edison, No. 4	16.0	8,440
2	Edison, No. 5	18.0	10,330
3	Weston, 6 M.	18.75	10,340
4	Weston, 6 W. I.	18.8	11,250
5	Weston, 7 M.	21.8	16,400
6	Edison, No. 10	24.3	13,150
7	Edison, No. 20	24.3	17,260
8	Edison-Hopkinson	24.5	13,200
9	Siemens	29.2	17,600
10	Westminster	39.4	22,000
	MOTORS.		
11	Immisch	14.6	7,600
12	Immisch	17.2	9,000
13	Immisch	24.8	14,700

Jour, Soc. Tel Engrs. Vol. XV.. 1886, p. 546.

Regarding drum armatures I have not been able to get such full information; but in Table III. are given the diameters and ampère turns on the armatures of some well-known machines. There seems to be little agreement, at first sight, between the diameter and the ampère turns; but if these are plotted as abscissæ and ordinates respectively, it will be found that a straight line can be drawn through the intersection of the axes, giving a very fair mean of all the points save 5 and 7, which are abnormally high. The relation denoted by this line is A_2 = diam. in centimetres $\times$ 570. It will be understood, of course, that the induction may be very different in these armatures, as well as the ratio between the external diameter and central opening. If we take the latter as .4 of the diameter, the ampère turns are 1,900 times the radial depth of the core, in centimetres.

9. MAGNETIZING FORCE REQUIRED TO COMPENSATE THE BACKWARD INDUCTION.

The weakening of the field by the current flowing in armatures wound on the Hefner von Alteneck principle has been studied by Drs. J. and E. Hopkinson; but from the fact that the lead upon which the weakening depends is, in Gramme-wound armatures, much greater and to a large extent indeterminate, it follows that, in designing, some approximate rule must be employed to fit the types of machines in which these are employed. We may estimate the effect of weakening in two ways: first, we may excite the magnets with a constant current, and measure the fall of E. M. F. due to the armature current; or, secondly, we may, by increasing the magnetizing force, keep the E. M. F. up to the same value when a current flows as when the machine is working at no load, measuring the ampère turns required to effect this compensation. The latter is the proper course to adopt, since, having pre-determined the magnetizing force required for the induction in the armature at full load, on the assumption that there are no disturbing reactions, we wish to know what addition is to be made to the force so determined. The weakening of the field is much greater in cylinder than in drum machines, owing to the greater lead required to obtain a sparkless collection; accordingly the magnetizing force necessary to compensate the backward induction must be greater for cylinders than for drums. Its actual value depends, necessarily, on several things beside the ampère turns on the armature, such as the degree of saturation employed, the ratio of armature to field section, the shape of the pole pieces, and the magnitude of the stray field. The particulars relating to the degree of saturation, the sections, stray field, etc., of the Phœnix machines have already been given, and from actual practice we find that there has to be added to the magnetizing force, in order to compensate the backward induction in these machines, .33 of the ampère turns on the armature. By the ampère turns on the armature is meant, as already stated, the product of the number of external conductors and half the total current. This is for a single horse-shoe machine. If there is a divided magnetic circuit constituted by two horse-shoes, with their like poles butting, the number of ampère turns here given has to be wound on each horse-shoe.

I have met with with some very curious rules for determining the compensating turns. These generally take the form of adding to the magnetizing force determined for the required induction at full load such additional ampère turns as will increase the induction about 5 per cent. It is assumed that at full load the E. M. F. will be as desired, the 5 per cent. extra being for compensation. This method is, of course, incorrect, for the magnetizing force added should be for a given machine some function of the armature windings. I believe that for most Gramme-wound machines the value of the compensation coefficient here given will hold good. The compensation coefficient for drum machines I have not yet been able to determine.

10. TOTAL MAGNETIZING FORCE.

To the magnetizing force required for a simple magnetic circuit as given in 1, we have to add the force required to compensate the backward induction, as given above. The equation for the magnetizing force now becomes for cylinder machines:

$$A_1 = Lf\left(\frac{N}{a}\right) + L_1.8\frac{v_1 N}{a_1} + L_2 f\left(\frac{v_2 N}{a_2}\right) + L_3 f\left(\frac{v_3 N}{a_3}\right) + \ldots + .33\,A_2,$$

where A_2 is the number of ampère turns on the armature.

If the machine is to be shunt-wound, and N is the induction corresponding to the E. M. F. at full load, A_1 gives the ampère turns on the shunt. If it is compound-wound, and N is the induction at full load, A_1 is the number of ampère turns on the series and shunt windings added. The ampère turns for the shunt alone are obtained by substituting for the induction at full load the induction on open circuit, the armature coefficient being, of course, here omitted. As a matter of fact, the value of v_2 increases between 0 load and full load, but for reasons already given this may in the calculation be neglected.

If the series coils are connected in series, to get the number of compensating turns on each horse-shoe we have only to multiply the external conductors on the armature by .165. It may be mentioned in passing that in the Phœnix dynamos the total series convolutions for ordinary compound machines are uniformly .31 of the convolutions on the armature; this, multiplied by the current, being the magnetizing force necessary to overcome the resistance of the armature and the series coils, and to compensate the backward induction. It will thus be seen that rather more convolutions are required for the latter purpose than for the former, and I think that in most dynamos of medium size the relation is very similar. The only extraordinary relation I know of is in the Victoria machine, where the compensating turns, instead of being a little greater than the turns required to overcome the resistance of the armature and series coil, are three times as great.

11. WORKING TEMPERATURE.

The ultimate rise in temperature of coils wound with double cotton-covered wire, varnished on the exterior, is, approximately, in degrees Centigrade,

$$C^0 = \frac{W\ 355}{S},$$

where W is the rate at which energy is dissipated in watts

and S the cooling surface in square centimeters. If, for the latter, we substitute square inches, S_1, the equation is

$$C^0 = \frac{W\ 55}{S_1}.$$

The coefficients have been obtained from practice, but they are liable to some uncertainty. In the cases from which they have been derived the coils were wound on formers of sheet iron, which fitted close to the magnets. These formers were fitted with brass end flanges, and in the spaces between the flanges and the wire, also between the body and the wire, was a thick layer of insulating material. The surface of the end flanges is not included as making up S or S_1, nor is the inside surface of the former next the magnet. Though insulated so well thermally, there is certainly a flow of heat toward the interior of the magnets and toward the end flanges, so that, as a matter of fact, the virtual cooling surface is greater than given above. Its value it is, however, difficult, to determine, while the above equation is approximately true for machines of medium size, and may be used for all cases in which the coils do not exceed 2½ or 3 inches in thickness.

For armatures—which in rotating induce a current of air—the equation is different, and the coefficient given above may have a much lower value, according to the velocity. and ventilation. For armatures the surface velocity of which is 50 ft. per second (3,000 ft. per minute), and the exterior diameter of the core 1½ times the interior, the length being about equal to the diameter, the rise is, approximately,

$$C^0 = \frac{W\ 225}{S},$$

or

$$C^0 = \frac{W\ 35}{S_1}$$

accordingly as the surtace is taken in square centimetres or square inches. Here the whole of the cooling surface inside, outside and at the ends is counted, W being the total watts dissipated in both electrical waste and hysteresis. The latter must, under no circumstances, be neglected, as it may reach 20 per cent. or more of the total. In giving the above equation, it should be stated that the armatures of the machines which furnished the results are closed at the commutator end, except at the periphery, where a draught of air through the centre from the pulley end is expelled. For slow-speed machines the coefficient is necessarily higher, and a larger surface must be allowed, or special means adopted, in the shape of vanes or blades, to force a draught through the armature. Experience only can be the guide here.

Considerable difference of opinion exists with reference to the temperature rise which should be permitted in dynamos. The rise of about 11 deg. C. allowed by the Admiralty is admitted by all engineers to be absurdly low; while, on the other hand, the machines sent out by some manufacturers get at their normal output dangerously near the temperature at which the insulating material would become useless. We have to steer between these two extremes, working far under the critical temperature, but, at the same time, not making machines too costly on account of the excessive surface allowed. It will be observed that from the manufacturer's point of view the settlement of this point is of great importance, since a competitor, by allowing a greater temperature rise, may put in a machine of less weight, and therefore less costly, though not necessarily less efficient.

In any case, the ultimate temperature of tbe machine ought not to rise above a certain value, whatever the temperature of the room in which it works. In my opinion, an ultimate temperature of from 70 deg. to 75 deg. C. may be permitted with perfect safety, but this should not be exceeded. Independently of the ultimate temperature, the rise in working should not be too great, and accordingly we have in the Phœnix dynamo fixed this limit at from 30 deg. to 35 deg. C. Machines working in atmospheres up to 35 deg. C. have a cooling surface, therefore, which will give in continuous working a rise of 35 deg. C.; when the temperature is higher the cooling surface is increased, so that the maximum temperature does not exceed 70 deg. C., the limit given. It will be seen from the formula that, for a rise of 35 deg. C. in the magnets, the cooling surface is ten square centimetres (1.56 s quare inches) per watt.

For armatures having the proportion stated, the surface requires to be about 7.3 square centimetres (1.13 square inches) per watt; but here it is less easy to formulate rules. Both interior and exterior surfaces are ventilated by the motion, the former generally being of a broken character, which aids the cooling. The temperature of these surfaces does not measure the temperature of the bottom layers of wire or of the armature core itself; and when I speak of a temperature of 70 degrees C.. I mean, of course, that of the hottest part. The difference of temperature between the interior of the core and the outside surfaces, in a machine of given carcass dimensions, depends on the gauge of wire with which the armature is wound. Obviously, the difference of temperature required to produce a given flow of heat depends upon the thermal resistance encountered, and, therefore, on the number of layers of badly conducting substance, in the shape of cotton covering, through which the flow takes place. For this reason, an armature wound with one layer of coarse wire requires a less cooling surface per watt to keep down the internal temperature than an armature wound with fine wire, even if the mass of copper is similar. In practice, allowance for this is made by working the small-gauge wires to a less current density. On account of the flow of heat being obstructed by badly conducting substances, armatures with cores constructed of wire always get hotter inside than those with plate cores.

Of course, it will be understood that the coefficient given for the rise of temperature will be greater for those armatures in which the central opening in the core is less than two-thirds of its external diameter. Where, for instance, it is half the external diameter, the inside radiating surface is diminished to three-fourths of that specified, and the temperature rise will be proportionally higher, unless a stronger draught of air is sent through the centre of the armature.

(To be continued.)

Another Large Contract.

An important contract has been let in Rochester, N. Y. The new street railway of that city has, after considerable investigation on the subject of electric tramways, adopted the Short series system for the entire line. This is specially interesting from an electrical standpoint as being the first large road which will be operated by the Short system. The contract is indeed a large one, being for two hundred 15-h. p. motors, and generators aggregating 1,100 h. p., the motors to be placed on one hundred 16-foot cars, which will be of the vestibule pattern, 16 feet long, and fitted each with two of the Short motors. The company will begin work as soon as the streets are in condition to be dug up. All the old rails are to be taken up and new steel rails of the latest pattern laid. The track will be for the main part double. The old cars will be disposed of, and in short the entire system changed into an electric road with all the modern improvements. The total expense of the change will be nearly $2,000,000.

The progress of this enterprise will be watched with a great deal of interest, as it involves such a radical departure from the ordinary method of electrical traction.

The Short system has been recently pushed to the front by the Brush interests, and all the motor companies operating the present parallel system of distributions will have especially keen interest in watching operations on the new road.

New Cabinet Medical Battery.

A very complete and handy form of cabinet battery apparatus is illustrated on this page. It has been especially designed to fill the want of a battery that shall require practically no attention, and the manipulation of which

A NEW CABINET MEDICAL BATTERY.

can be effected with great facility. The various connections and switches for placing any desired number of cells in circuit are placed on top of the cabinet. By means of the compound circle switch A any number of cells can be thrown in and cut out of the circuit singly and without shock.

To select any number of cells in any number of series, the short arm is allowed to rest on the post marked, and the long arm is moved around the circle, say to button 20, when 20 cells will be connected in the circuit.

Suppose it is desired to cut out the five cells, the short arm is moved to post 5, when the number of cells will be those that are represented by posts between the two arms, that is to say, 15.

B is a current changer for reversing the polarity of a galvanic current without removing electros, and C an automatic interrupter for rapidly or slowly breaking the circuit. It is operated by an independent battery, and so arranged as not to short circuit the cells, and is controlled by a small switch D. The centre bearing switch E controls the current. A constant current is obtained when on post I, an interrupted one on post 2 when the automatic interrupter is in operation. When on post 3 the current passes through the galvaniscope, and also through the patient. F is a circuit button, and by simply raising the screw, the current of any of the galvanic combinations is instantly cut off.

G is a galvaniscope and H H are cord posts for the galvanic and faradaic current. By means of the faradaic coil J ten different combinations of currents can be produced, the circle switch K making the various combinations.

The battery is also fitted with a current reverser L, for changing the polarity of the faradaic currents without removing the electros. When the current reversers are moved toward the left the positive pole is the left hand cord post, and vice versa.

Among the advantages claimed for the battery, it will be observed that the trays containing the cells can be withdrawn from the cabinet without disturbing a wire. All chance of short-circuiting cells by connecting wrong wires from circle to cells is avoided.

Each cabinet is furnished with forty cells of the improved "Law" form, each cell having an electromotive force of 1.5 volts and internal resistance of .5 of an ohm.

The battery requires no other attention than the renewal of the zincs and sal ammoniac. The coil and automatic interrupter are operated by three additional cells of the Smee form. The whole forms a very handsome piece of cabinet work for a physician's office.

These batteries are manufactured by the Jerome Kidder Manufacturing Company of this city.

Board of Electrical Control.

Mayor Grant opened the meeting of the Board of Electrical Control on the 26th ult., by stating that he had received from the East River Electric Light Company a letter containing sundry complaints, and he regarded this letter as an official notification that the rates for the subways were too high. Ex-judge Kelly stated that it was for the purpose of asking the board to regulate rentals. The Mayor said a day would be specified for a special hearing on this subject, as it is a very important one. The representatives of the various electric lighting companies could be present, and the matter could be considered in all its bearings.

The letter of the East River Electric Company is of special interest, inasmuch as it presents a phase of the situation which concerns some of the electric lighting companies deeply. It showed that the company was obliged to forego its contract for furnishing lights on Sixth Avenue in consequence of the excessive rental of the subways, which amounted to $50 per lamp per year. The city paid only $127.75 per lamp, and the subsidiary lamp connections involved an expenditure of $75 per lamp, bringing the virtual rental up to at least $125 for the first year, exclusive of the great cost of underground conductors, and the additional expense that had to be incurred in making tests as required by the rules of the Board.

This imposed on the company conditions practically prohibitive, so far as the maintenance and extension of their business was concerned. As a further proof that the present rentals are exorbitant and unjustifiable, attention was directed to the statement made in court before Judge Andrews by the Consolidated Subway Company, through its council, Mr. Cohen, that the average cost of building ducts was about $3,000 per mile, and also to the statistics recently placed before the American Institute of Electrical Engineers by Mr. Wm. Maver, Jr., showing that the average cost of the ducts was about $3,000 per mile, and that this cost was for work which was largely experimental, and in difficult and trying places. This cost includes a profit of 15 per cent. on the actual outlay of the sub-contractors, and an additional profit of 15 per cent. on the sub-contractors' bill to the Phenix Construction Company. The future construction naturally will be much more economical, and can be handled with much greater ease.

At this point of the perusal of the letter the Commissioner of the Department of Public Works said:

"I state right here that no matter what the law says to the contrary, I shall refuse permission to dig up the streets after the paving is down."

The letter of the East River Company went on to state that C. H. Jackson is the authority for the assertion that 3-inch ducts are rented and maintained in Philadelphia for $250 per mile per year, and that on Oct. 14 of last year W. H. Peckham, representing the Standard Company, and P. D. Cravath, representing the Brush associated companies, presented in writing a proposition that if permitted by the Board to build subways, the rent should not exceed $750 per year per mile. In conclusion the company referred to the almost universal use that is now being made of electricity in all

ranks of life and branches of business, and asked the Board to fix the rentals of the subways at such a figure as would enable them to bring the current within the reach of consumers.

This very clear and reasonable presentment of existing conditions was handed to the chief engineer of the Board, who will probably have something to say about it at the next meeting of the Board. The price now paid by the company for the conduits is $3,300 per mile.

In the course of a discussion which followed as to the granting of permission to the Standard Company to use cement-lined pipes instead of iron pipes, the Mayor said:

"I don't propose that the Standard Company shall come into this Board and say they have had no opportunity to get their pipes. They may just as well understand my position. It will be very difficult to convince me that you can't get iron pipes if you order them early enough."

The Mayor insisted that the distributing ducts should be laid immediately. Mr. Cohen, for the Consolidated Subway Company, said this could not be done for the reason already given, that the materials were not ready, but that by April 15 he would guarantee that the work should be begun. He urged the issuance by the Board of an order that the work should be begun, and that the term of completion should be named at the next meeting. The Mayor wanted to know exactly how long the work would take, and a sub-contractor present said it could be done in thirty-five days. Mr. Cohen strenuously questioned this, and a resolution was eventually put and adopted that the work should be begun on April 10, and be completed within sixty days from March 26.

At the previous meeting of the Board, the East River and Harlem Electric Light Companies entered a formal complaint that the Consolidated Subway Company would not give them ducts for which they had presented applications in due form, but since then their application has been granted, and the Board now gave an extension of time in which they can put their wires underground to May 10.

The most prominent feature of the meeting was the determined stand taken by Mr. Gilroy, who laid down emphatically the position which would be assumed by the Department of Public Works. He said:

"It is a question now whether the people own the streets, or the the subway companies. I have no objection to their putting down subways in streets that have yet to be repaired, but if they want to put subways down in streets that have been newly paved, I wish to state right here, they will have to get the courts to help them, for they won't get any permits from me unless they do."

It was then arranged that the Engineer of the Board should meet Mr. Gilroy the following day at the office of the Commissioner of Public Works, and that the question should be discussed in the presence of the representatives of the subway and electric lighting companies.

This meeting was held accordingly, and a list of streets in which subways could be at once laid down was drawn up for presentation at the next meeting of the Board.

Report of the Senate Committee.

On March 27 the Senate Committee that has been investigating the electric lighting problem in this city issued its report at Albany, an abstract of which we append. The mass of testimony taken was enormous, and the committee is to be congratulated on having extracted from the conflicting opinions advanced so satisfactory a conclusion.

A difference of opinion exists among experts as to what voltage would cause death, or whether there is any difference in the danger to life between the alternating and continuous currents. It seems to be conceded, and may be taken as a safe rule, that currents of 250 volts or under, either direct or alternating, are safe. It appears that sixteen persons have been killed in the city of New York during the past three years from electrical currents, most of them being employés of electric lighting companies. Most, if not all of these deaths were caused by the continuous current used for arc lighting. As far as the committee could ascertain, no accident has been caused by underground conductors. The cause for most of these deaths appears to have been carelessness on the part of the electric companies in using poorly insulated or badly arranged conductors, and in neglecting other precautions required for safety. It appears doubtful if an overhead system of wires carrying high tension currents could be, under any circumstances, maintained in the crowded streets of the city of New York without more or less danger to the public.

The remedy for these evils, in the opinion of your committee, lies in the speedy burial of all electric light and power conductors in New York City and other cities having a population of 125,000 or more, and the enforcement in all cities and towns where central station electric lighting is carried on of such rules and regulations as shall compel the companies properly to construct and maintain their plants and adopt such precautions as are required to insure safety to the public. Whatever doubt there may have been heretofore regarding the possibility of successfully operating underground conductors has been removed by the experience of New York City with the subways and by the testimony taken by your committee, which is uniformly to the effect that currents of high and low tension, direct or alternating, may be distributed by means of underground conductors with entire success, without interference with the telephone and telegraph services and with safety to the public. In cities and towns of under 125,000 inhabitants, where the streets are less crowded and where overhead telephone and telegraph wires are less numerous, electric light wires may be operated with safety, provided proper precautions are taken. But even in cities of less than 125,000 inhabitants we believe the interest of the public would be best served by placing the electric light wires in the principal streets underground.

The testimony, including that of representatives of the New York Board of Fire Underwriters, shows that the fire risk in connection with electric lighting is no greater than in the use of gas, if as great. The testimony shows that both the high and low-tension systems can be made equally safe to life and property by the use of proper safety devices. The testimony of experts is to the effect that the converter system, involving the use of a high-tension alternating current in the street mains, affords a system which is, if properly guarded, free from danger to either life or property. It is, therefore, the opinion of your committee that it would be unwise and unjust to the public to restrict by legislation the voltage of currents used in furnishing electric light and power. The danger from the high-tension currents used in lighting being admitted, the wires carrying them should be kept out of reach of the public, as should street wires under the conductor system.

Considering the testimony taken, we do not think it possible for the Legislature to form satisfactory rules and regulations for application to an industry which is not only highly technical, but constantly developing and presenting new conditions, rendering rules proper this year possibly obsolete next year. There should, however, be some form of supervision by properly qualified State or local authorities over the commercial use of electricity, analogous to the supervision now exercised over steam boilers. As already indicated, there are two questions upon which the Legislature might properly act by providing, first, that no electric light or power current of over 250 volts pressure be allowed to enter any building; second, that after, say January 1, 1892, no overhead conductors carrying currents for lighting or power purposes be allowed in any street, highway or public place in any city of the State having a population of 125,000 persons or over, and that the local authorities in the various cities coming under this description, in the absence of any State authority, be empowered and directed to make proper provision for the burial of such wires.

Some Data Covering the Comparative Cost of Incandescent Lighting.

From the carefully kept records covering the period of two years from Jan. 1, 1888, to Dec. 31, 1889, of the large isolated incandescent electric lighting plant in the basement of a well known office building, the following data have been gathered in the hope that they may be of service to some of our readers.

The total dynamo capacity of the plant is 2,100 16 c. p. lamps; but 2,900 lamps have been wired in circuit, though a greater number than 2,000 lamps have been in actual use at one time only on two or three occasions.

The plant has been in constant operation during every hour of the 24 months, with two exceptions, the first of less than two minutes, and the second of several hours, while some change in the position of the shafting was being made. Only two armatures were injured during the 24 months, necessitating a total expenditure of $160 to repair same.

The total number of lamp hours for 1889 was 8,831,435; and for 1888, 8,353,080 hours, making a total of 17,184,515 hours.

The comparative life of the lamps used during 1888 was found to be 3,250 hours, while this average had increased during 1889 to 4,464 hours. As the lamps used were all furnished by one company, the natural inference is that a higher grade of lamp is now being supplied, more especially as during the month of November, 1889, the comparative average life of the lamp has reached the high figure of 5,629 hours.

The total amount of coal consumed during 1888 was 1,337 tons, and during 1889, 1,406 tons, and for each pound of coal consumed a lamp was maintained for an average period of 2 hours 48 minutes.

The average cost of maintaining a 16 c. p. lamp for 24 hours during the period mentioned was 6.82 cents. The cost during the first month of the period, January, 1888, was 8.96 cents per each day of 24 hours, but careful management had reduced that cost by November, 1889, to 5.80 cents per lamp for 24 hours.

A careful study of the above abstract should convince every owner of an office building that it will be to his interest to have an electric light plant installed, with a view of furnishing electric light free to his patrons as an inducement to occupy his offices, as the total yearly average cost per lamp in a modern office building should not exceed *four dollars per year per light*, including *every possible expense*, aside from electric or combination fixtures, owing to the limited necessity for artificial light during the greater portion of the time the tenants are in their offices.

English Notes.

(From Our Own Correspondent.)

LONDON, March 12, 1890.

MUNICIPAL AUTHORITIES AND THE ELECTRIC LIGHTING ORDERS.—At the annual meeting held a few days ago of the Association of Municipal Corporations, it was decided to ask the President of the Board of Trade to receive a deputation on the subject of electric lighting powers as affecting local authorities. A deputation subsequently waited upon the Board of Trade and urged that the local authorities should be allowed to transfer the electric lighting powers obtained by them to any one they might think fit, divesting themselves at the same time of all further legal responsibility. In most of the provisional orders hitherto issued, stringent clauses, restricting the right of companies to transfer their powers have been inserted, and in no case have the original holders been permitted to divest themselves of legal responsibility. If the present demand of the local authorities had been granted it would have been another step in the direction of making them privileged persons. I am therefore glad to say that the Board of Trade officials, while expressing their readiness to place local authorities upon equal terms with other bodies, declined firmly to go further and to allow local authorities to obtain powers and then transfer them, together with all the responsibilities, to the first-comer.

TELEPHONES AND THE GOVERNMENT.—In the House of Lords the other night the Duke of Marlborough raised the subject of telephone purchase, but his questions elicited nothing more definite by way of reply than that "the relations between the Telephone companies and the Post Office were under the consideration of the government." In Juue, however, under the terms of the original license granted to the Telephone companies, the first opportunity will occur to take over the entire telephonic system of the United Kingdom, so that this attitude of the government can not be persisted in much longer. There is a general feeling in this country that the telephones will ultimately be taken over by the government, but, on the other hand, there is an undoubted determination on the part of the post office not to recognize the existence of "vested interests," or to pay exorbitant prices for the telephone material of the existing companies. It is quite possible, though not very probable, that a compromise will be arrived at something like that which exists in some continental countries—namely, the operation of the trunk wires by the government and the local exchanges by the companies. In consideration of a more secure tenure of the more profitable part of their business —viz., local exchange work—the telephone companies might consent to transfer their trunk wire system to the post office and to pay an even more substantial royalty than the 10 per cent. of their gross receipts, which they now annually hand over to the post office.

CABLE RATES.—Mr. J. Henniker-Heaton, whose one and laudable object in life, for some years past, has been the introduction of Imperial penny postage, and the reduction of the cable rates between Great Britain and her colonies to the uniform figure of one shilling per word, recently devoted a paper at the Society of Arts to these questions. Mr. Henniker Heaton's language would be nothing unless vigorous, and his paper at the Society of Arts contained the usual percentage of pleasant epithets, such as "long-headed monopolists," "wily spiders," etc. A few days ago Sir James Anderson was interviewed with regard to Mr. Henniker-Heaton's statements by a representative of an enterprising evening paper. With regard to the Imperial Government taking over the submarine system of the Eastern and Eastern Telegraph Extension Companies, Sir James Anderson remarked that he foresaw considerable difficulties in the way of the British Government obtaining a footing in foreign and often hostile countries for the purpose of cable stations. As to the one shilling a word tariff he was of opinion that it was impossible, and he showed that Australia alone received at present 1s. 2d. per word for the transit of messages across the Australian continent. Asked what he thought of the Pacific cable scheme, Sir James Anderson remarked that from a business point of view he failed to see what *raison d'etre* it could have, although he was by no means prepared to say that it would never be laid. since at certain times money can be obtained for any wild scheme, and many people seemed to think that they ought to fulfill Shakespeare's prophecy and "put a girdle round the earth." In his opinion cables should be laid not across broad and fathomless oceans, where traffic cannot be developed, but in moderate depths (under a thousand fathoms) and along coasts, touching at every possible commercial port. Then the cables could easily be repaired and the shareholders have a paying property. In reply to Mr. Henniker Heaton's vigorous denunciation Sir James Anderson showed that the Eastern Extension Companies had always been ready to make every possible reduction in their tariff consistent with paying a dividend to their shareholders, and he pointed out that the recent marvelous developments of the code system had gone a long way towards reducing the cost of cablegrams. Of the messages carried by the Eastern Telegraph Company nearly 40 per cent. were under five words apiece.

THE ELECTRIC METER IN COURT.—Messrs. Chamberlain & Hookham, of Birmingham, the makers of the Hookham meter, seem to be fated to have their meter brought prominently before the public by the medium of the law courts. This was the case a few weeks ago, and now Messrs. Chamberlain & Hookham have been obliged to sue the Cadogan Electric Light Company for the sum of £31, the price of two of their meters. The defendants put in a counter-claim for £25, which they allege they lost, owing to the failure of the meters to register electricity supplied to customers. Counsel for the Cadogan Company contended that Messrs. Chamberlain & Hookham's circular relating to the meter stated that it was a reliable piece of apparatus, and that since it was not found to be so the Cadogan Company claimed to be reimbursed for the loss they had sustained. Counsel contended that a trade circular of this description amounted to a warranty. Judgment was finally given for the plaintiffs, Messrs. Chamberlain & Hookham, on the common-sense ground that the trade circular did not amount to a warranty, and that as long as the statements made in it were of a bona-fide character people who purchased on the strength of the circular had no legal remedy, even if the article purchased did not come up to the standard of the circular. I am afraid that these frequent appearances of the electric meter in the law courts will intensify the belief held by some people, that no such thing as a reliable electric meter exists.

CITY OF LONDON AND SOUTHWARK SUBWAY RAILWAY—On Wednesday last the Lord Mayor and a large party connected with railway undertakings made a trial trip over the line of this company. The journey from the city station to the one on the far side of the river, was accomplished without any hitch. Unfortunately, after Mr. Greathead (the engineer) had expatiated on the novelty of the enterprise, it was found when the Lord Mayor and party took their seats for the return journey that the train would not start. After being kept at the station something like an hour over the time laid down in the programme, the electric locomotive was induced to perform its functions and the train ran swiftly back to the city terminus. The conventional luncheon then took place, but owing to the delay which had occurred, the majority of the "distinguished visitors" were obliged to forego the hospitality of the chairman and directors of the city of London & Southwark Subway Company. It was explained after the luncheon that the unfortunate mishap which had occurred in the morning had nothing to do with the permanent way, electric locomotive or the generating apparatus, but was simply owing to the fact that an obstinate turncock of the Southwark & Vauxhall Water Company had for some time refused to turn on the water required at the generating station. It was perhaps fortunate under the circumstances that the members of the technical press were rigorously excluded. As I have already mentioned, it is not expected that this line will be opened to the public until this summer.

A Decision of Importance to Electrical Inventors.

In the case of Pohl vs. The Anchor Brewing Company.

This is a suit in equity, brought on the 16th of April, 1889, in the Circuit Court of the United States for the Southern District of New York, by Carl Pohl and Charles Zoller against The Anchor Brewing Company, a corporation, for the infringement of letters-patent No. 213,447, granted March 18, 1879, on an application filed January 3, 1879, to Carl Pohl, for an "improvement in barrel and cask-scrubbing machines."

The patent is granted on its face for the term of seventeen years from March 18, 1879, "subject to the limitation prescribed by sec. 4,887, Rev. Stats., by reason of German patent dated September 6, 1877, and French patent dated September 3, 1877." It appears, by translations into English of the German and French patents, annexed to the bill, that the German patent began to run September 6, 1877, and its longest duration was until December 12, 1891, and that the French patent began to run from September 3, 1877, and ran for fifteen years.

The defendant put in a plea to the bill setting forth that, at the time when Pohl applied for the United States patent, and at the time it was issued, he was a citizen of the empire of Germany; that, on the 6th of September, 1877, a German patent was issued to him for the same invention, for the term of 15 years; that, under the German patent law of May 25, 1877, he was required to pay certain annuities on the German patent, and to work the invention in the empire of Germany in the manner and for the term specified by that law; that in default thereof, the term of the German patent would expire, and the rights and privileges of the patentee under it would become forfeited and cease; that Pohl neglected and failed to pay the annuities, and to work the invention in the empire of Germany in the manner and time required by that law, whereby and under the provisions of that law the German patent became forfeited in 1880, and the term thereof expired; that, by reason thereof, and under the provisions of section 4887 of the Revised Statutes, the United States patent expired and the term thereof ended in 1880, and prior to the commencement of this suit, and, at the time it was brought, the plaintiff had no title to the patent and no rights under it; that, on on the 3d of September, 1877, a patent was issued to Pohl for the same invention by the proper authorities of the government of France, for the term of fifteen years, and subject to the provisions of the French patent law of July 5, 1844; that, under those provisions, a a patentee who failed to pay his annuity as required by that law, before the beginning of each year of the duration of his patent, or who failed to put his invention in working order in France within two years from the signature of the patent, or who ceased such working during two consecutive years, would forfeit all right under the patent; that Pohl neglected and failed to pay his annuity as required by such law, and failed to put his alleged invention in working order in France within two years from the signature of the patent, and ceased such working during two consecutive years, whereby, under the provisions of the French patent law, the French patent was forfeited and the time and term thereof expired, and the rights of Pohl there underceased; and that, under the provisions of sec. 4887 of the Revised Statutes, the United States patent expired and the term thereof ended prior to the commencement of this suit, and at that time the plaintiffs had no title to the patent and no exclusive rights thereunder.

The plea was set down for argument, and the Circuit Court, held by Judge Wallace, sustained the plea and dismissed the bill. To review that decree the plaintiffs have appealed.

Section 4887 of the Revised Statutes, on which the question involved in this case arises, reads as follows: "No person shall be debarred from receiving a patent for his invention or discovery, nor shall any patent be declared invalid, by reason of its having been first patented or caused to be patented in a foreign country, unless the same has been introduced into public use in the United States for more than two years prior to the application. But every patent granted for an invention which has been previously patented in a foreign country shall be so limited as to expire at the same time with the foreign patent, or, if there be more than one, at the same time with the one having the shortest term, and in no case shall it be in force more than 17 years." The particular question involved is as to the meaning of the language of the second paragraph of the section.

The United States patent in the present case, granted March 18, 1879, was granted for an invention which had been patented previously, in September, 1877, in Germany and in France. It must be, therefore, by the terms of section 4887, so limited as to expire at the same time with that one of the two patents, German and French, "having the shortest term." The German patent on its face appears to have been granted for a term extending from Sept. 6, 1877, to Dec. 12, 1891; and the French patent for a term extending

for fifteen years from Sept. 3, 1877, that is, until Sept. 3, 1892. If the United States patent does not expire until the end of the term expressed on the face of that one of the two patents, German and French, which has the shortest term so expressed on its face, it does not expire until the end of the term so expressed on the face of the German patent, namely, Dec 12, 1891; and so it had not expired when this suit was commenced, and has not yet expired. On the other hand, if it expired when the German patent became forfeited by reason of the facts alleged in the plea in regard to it, or when the French patent became forfeited by reason of the facts alleged in the plea in regard to it, the United States patent expired prior to the commencement of this suit.

The opinion of the Circuit Court in the present case (39 Fed. Rep. 782) proceeded upon the view that the "term" of the foreign patent, referred to in section 4887 was not the original term expressed in it, but its actual period of existence; and the United States patent expired when the foreign patent having the shortest term was terminated by its lapsing or becoming forfeited in consequence of the failure of the patentee to comply with the requirements of the foreign patent law. The Circuit Court regarded the decision of this court in Bate Refrigerating Co. v. Hammond (129 U. S., 151.), made in January, 1889, as requiring such decision.

The question involved in the present case has been decided by several of the Circuit Courts.

In Holmes Electrical Protective Company v. Metropolitan Burglar Alarm Company (21 Fed. Rep.. 458), in the Circuit Court for the Southern District of New York, in August, 1884, it was held by Judge Wheeler that section 4887 meant that the term of the United States patent should be as long as the remainder of the term for which the foreign patent was granted, without reference to incidents occurring after the grant of the foreign patent; that that section referred to the fixing of the term of the foreign patent, and not to the keeping of it in force; and that the term of the United States patent was not affected by the fact that a prior English patent had been suffered to lapse by the non-payment of a tax.

In Paillard v. Bruno (29 Fed. Rep., 864), in Circuit Court for the Southern District of New York, in December, 1886, it was held by Judge Wallace that, under section 4887, a United States patent, for an invention which had been patented previously in England for the term of fourteen years, did not expire until fourteen years from the date of the English patent, notwithstanding the grant of the latter patent had terminated by the failure of the patentee to pay a stamp duty required to be paid as a condition of the continuance of the grant beyond the term of three years.

In Bate Refrigerating Company v. Gillett (31 Fed. Rep., 809), in the Circuit Court for the District of New Jersey, in August, 1887, before Mr. Justice Bradley, it was held that where an English patent was granted for a certain term, provided that if the patentee should not pay a stamp duty within a certain time, the patent should cease and determine, a United States patent afterward granted for the same invention was not affected by a forfeiture of the foreign patent subsequently incurred by a failure to perform such condition; that the term of the English patent fixed the term of the United States patent; that the subsequent fate of the English patent had no effect upon the United States patent; and that the life of each, after its inception, proceeded independently of the life of the other. As authority for this view Mr. Justice Bradley cited the cases above referred to of Holmes Electrical Protective Company v. Metropolitan Burglar Alarm Company and Paillard v. Bruno.

Prior to the decision of the Circuit Court in the present case, and in May, 1889, in Huber v. N. O. Nelson Mfg. Co. (38 Fed. Rep., 830), in the Circuit Court for the Eastern District of Missouri, before Judge Thayer, it was held that a United States patent, granted after an English patent for the same invention had lapsed and become void by reason of the non-payment of a stamp duty, was granted without authority of law. This decision was made on the interpretation which the court gave to the case of Bate Refrigerating Co. v. Hammond.

But we think that the question involved in the present case is not the same as that decided in Bate Refrigerating Company v. Hammond, and is not controlled by the decision in that case. There a United States patent was granted in November, 1877, for seventeen years. A patent for the same invention had been granted in Canada to the same patentee for five years from January, 1877. The Canadian patent was, in December, 1881, extended for five years from January, 1882, and also for five years from January, 1887, under a Canadian statute passed in 1872. The question involved was whether, under 4887, the United States patent expired in January, 1882, or January, 1892. This court, limiting itself to the precise question involved, said that it was "of opinion that, in the present case, where the Canadian statute under which the extensions of the Canadian patent were granted, was in force when the United States patent was issued, and also when that patent was applied for, and where by the Canadian statute, the extension of the patent for Canada was a matter entirely of right, at the option of the patentee, on his payment of a required fee, and where the 15 years' term of the Canadian patent has been continuous and without interruption, the United States patent does not expire before the end of the 15 years' duration of the Canadian patent." This was said on the view, expressed elsewhere in the opinion, that the Canadian patent did not expire, and it never could have been said properly that it would expire, before January, 1892. The ground of this conclusion was, that the "term" of the Canadian patent granted in January, 1877, was by the Canadian statute at all times a term of 15 years' duration, made continuous and uninterrupted by the action of the patentee, as a matter entirely of right, at his own option.

By parity of reasoning, as applied to the present case, section 4887 requires that the United States patent shall be so limited as to expire at the same time with the term limited by the foreign patent issued prior to the issuing of the United States patent, having then the shortest time to run. There is nothing in the statute which admits of the view that the duration of the United States patent is to be limited by anything but the duration of the legal term of the foreign patent in force at the time of the issuing of the United States patent, or that it is to be limited by any lapsing or forfeiture of any portion of the term of such foreign patent, by means of the operation of a condition subsequent, according to the foreign statute. In saying that "every patent granted for an invention which has been previously patented in a foreign country shall be so limited as to expire at the same time with the foreign patent," the statute manifestly assumes that the patent previously granted in a foreign country is one granted for a definite term; and its meaning is, that the United States patent shall be so limited as to expire at the same time with such term of the foreign patent. Such term was held, in Bate Refrigerating Company v. Hammond, to be fifteen years and not five years.

This view is made conclusive by the requirement of section 4887, that if there be more than one prior foreign patent, the United States patent shall be so limited as to expire at the same with that one of such foreign patents "having the shortest term." This means the foreign patent which, at the time the United States patent is granted, has then the shortest term to run, irrespective of the fact that the foreign patent may afterward lapse or become forfeited by the non-observance of a condition subsequent prescribed by the foreign statute.

In the view that section 4,887 is to be read as if it said that the United States patent is to be so limited as to expire at the same time with the expiration of the term of the foreign patent, or if there be more than one, at the same time with the expiration of the term of the one having the shortest term, the interpretation we have given to it is in harmony with the interpretation of the words "expiration of term" in analagous cases. (Oakley v. Schoonmaker, 15 Wendell, 226; Beach v. Nixon, 9 N. Y., 35; Farnum v. Platt, 8 Pick., 338.) In those cases it was held that the words "expiration of term" do uot mean expiration of term through a forfeiture by breach of a condition, but mean expiration by lapse of time.

The decree of the Circuit Court is reversed, and the case is remanded to that court with a direction to overrule, with costs, the plea of the defendant, to assign it to answer the bill, and to take such further proceedings as shall not be inconsistent with the opinion of this court.

The Huntington Electric Search Light is being experimented with in San Francisco harbor. The search light used on war ships is usually a very heavy apparatus, weighing about 1,000 pounds, and costing about $10,000 as made in France. This Huntington light weighs about 130 pounds, is of 4,000 c. p., and costs $350. One man can easily handle it, and the light is concentrated in parallel rays, instead of being diffused over a wide area as in the war lights. At the distance of half a mile on a dark, clear night, buoys could be plainly seen and every rope in the rigging of a ship. It is claimed that the light will penetrate the thickest fog sufficiently to prevent collisions. When turned vertically, a column of light three-quarters of a mile high is produced, visible on dark, clear nights many miles away, and visible in the thickest fog at one-third of a mile distant.

Troy Hill, Pa., and Allegheny will soon be connected by means of an electric railway.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-177 TIMES BUILDING, NEW YORK. March 30, 1890.

C. R. Huntley, of the Brush Electric Light Company of Buffalo, is in the city looking up underground business.

In Town this Week—P. C. Burns, of the St. Louis Electric Company, is in town, and is out with a new line of porcelain cut-outs, switches and appliances.

Mr. H. Baum, general manager of the Fidelity Carbon Company, of St. Louis, was in town the past week, and speaks very sanguinely of the volume of business on hand and the successful reorganization of his company.

Curtis & Dean, 115 Broadway, have recently filled an order for three double 30 h. p. truck and car equipments for the Troy & Lansingburg Street Railway, and have just organized a working department for the introduction of isolated plants.

Dr. Norvin Green was in Louisville during the cyclone of last week, and some anxiety was felt by his friends here, although his home was out of the immediate destructive path. He went to Louisville to celebrate his golden wedding, which anniversary fell on Tuesday last.

Mr. T. W. Harrington, who is well known among our readers as a salesman for the Western Electric Company, New York, has taken charge of the Tropical American Telephone Company's New York branch, and assumes the duties April 1, in conjunction with Mr. H. W. Bates, who has been in charge since July, 1889. His long experience in the telephone field will make his services valuable to the company.

The Telegraphic Tournament at Hardman Hall, April 10, promises to be a marked success in every way. The judges have decided that the awards are to be based on the fastest time made, provided the sending is readable. Mr. W. P. Phillips offers an additional prize of $25 to the contestants in each of the four classes "who is adjudged to have done the most finished and accurate sending in the quickest time."

J. W. Godfrey, of the New York Insulated Wire Company, was in New Orleans on the 18th of last month, and appointed the Southern Electrical Manufacturing Supply Company agents for his concern. They will carry a full line of wires, cables, etc., and are said to be the only house within 500 miles of the city (Crescent City) that is carrying a heavy stock. Mr. Gallaher, at the home office, says that the business has boomed surprisingly the past week.

The Weston Electrical Instrument Company, Quitman, near Baldwin street, Newark, N. J, who have confined their attention to the manufacture of the Weston ammeters and voltmeters, have secured four floors of the fine building at 114 William street, Newark, which they are fitting up with a full line of machinery for the manufacture of a general line of electrical instruments. They have improved the forms of their ammeters and voltmeters and increased their range.

Mr. G. F. Shaver, vice-president of the Shaver corporation, manufacturers of the Molecular telephone, after years of labor in introducing his "little talkers" into all lines of business, has secured Mr. H. H. Warner, the great patent medicine man, as a partner. Mr. Warner has sold his patent medicine business to a syndicate for $5,000,000, and has bought a one-half interest in the Shaver concern at par, and will devote his great energies to pushing to a successful issue the business of the future competitor of the electric telephone.

Will Not Affect their Interests.—Mr. J. B. Van Sise, attorney for the Electrical Accumulator Company, anent Judge Coxe's decision, tells me that he went into court for the accumulator people, requesting the judge to withhold his decision until his company could complete their defense in a separate suit involving the same questions as those in the case of Brush vs. Julien. Judge Coxe felt obliged, however, to render his decision before that, but it was understood that it should not affect the Electrical Accumulator Company's rights.

The United Electric Light and Power Company, of New York City, has just placed with the Westinghouse Electric Company an order for alternating current incandescent apparatus to increase its present capacity of 28,000 lights to the extent of 15,000 lights. To fill this order, five 3,000-light dynamos will be as soon as possible shipped from Pittsburg. Once these machines are in the station of the United Company, and in operation, that organization will have the largest central station incandescent lighting plant in the UnitedStates. Its arc lighting business is likewise growing with great rapidity; it is now employing the new Westinghouse arc lighting system to a total capacity of 1,800 lights, and last week was obliged, in order to keep up with the demand for light, to order an additional 125-light machine from the Westinghouse Company. This new arc lighting system, it may be remarked, is quickly gaining in favor wherever introduced, and the manufacturers find it impossible to keep up with the orders which are coming to them from all parts of the country.

Mr. George D. Allen, long and well known in electrical circles, died at his home in Brooklyn on Friday, March 28, aged 46 years. Mr. Allen organized the Excelsior Electric Company in August, 1881, and installed the first arc lamp in his native city of Brooklyn, in Frederick Loeser & Co.'s store, and was generally credited with installing the first arc light plant in this country. He has always retained the position of secretary and general manager of the Excelsior, and all the financial and commercial business of the concern developed upon him up to a short time ago, when he secured new capital, and was able to secure needed rest. Mr. Allen was also a man of marked personal characteristics, with a somewhat brusque manner, but popular withal and generous to a fault. Possessed of wonderful energy, pluck and commercial ability, it was through his labors that one of the most successful enterprises of the times was established. Funeral services were held at Mr. Allen's late residence, 461 Washington avenue, Brooklyn, Monday, March 31, Rev. T. De Witt Talmage, D. D., officiating. The interment was in Greenwood cemetery.

The New York Electrical Society's meeting at the Equitable Building, 120 Broadway, was an ovation. The Westinghouse Electric Company's exhibition plant was virtually turned over to the society for investigation. Since our last notice of this plant the main features of interest have been transferred to one of the booths in the lobby from the basement, and has had many interesting features added to it. The current is generated in the basement from a 750 16 c. p. light, 1,150 volt alternating dynamo, driven from a 75 h. p. Westinghouse compound engine. The booth contains ten converters, two Shallenberger meters, about 150 lamps from 16 to 150 c. p., run in series and multiple arc to show the advantages of this system; four Tesla motors driving fans on armature shaft; ¼ h. p.; one bank of 80 lamps—can switch in and out any number; to show the sensitive working of the meters. A demagnetizing coil was practically demonstrated by magnetizing and demagnetizing a screw driver. A novel cigar lighter consists of a coil of platinum wire as resistance in asbestos. The converter system is illustrated by two coils; mounted on one coil is a 16 c. p. lamp, receiving its current by induction. Six different styles of ceiling or lamp cut-outs are shown. The lamps are shown in different positions and groups for the advantageous diffusion of light; one double pole throw switch to show the difference between alternating and direct current. Mr. W. T. Wheeler, the electrician of the building, has his direct current connected to this switch, and one 150 c. p. lamp in the ceiling in this booth. The booth is in the care of Wm. Hubbard, electrician.

W. T. H.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 8, Cook Building, cor. Franklin and Congress Sts.,
BOSTON, March 25, 1890.

A New Car.—The Tripp Anti-Friction Bearing Company are building a large car on a new plan for the West End Railway.

The Standard Electric Company, of Vermont, have on exhibition at their Boston office one of their 300-light incandescent machines.

Wheels for the West End Company.—The American Steel Car Wheel Company are making a large number of all steel wheels for the West End Railway.

The Chelsea Gas & Electric Company have just added a 650-light alternator to their plant. This company contemplate a number of changes in their station shortly, which will enlarge it considerably.

The West End Railway Company are having a large number of cars built after the pattern of the Robinson radial car, which is six feet longer than any ordinary street car, and has three sets of wheels, for use on the electric lines this summer.

Admitted to Partnership.—David A. Andrews, Jr., and Charles B. Price were admitted as members of the firm of Pettingell, Andrews & Co., March 1. The new members have been with the firm some years, and are receiving the congratulations of hosts of friends.

Geo. Cutter, of Chicago, E. H. Johnson, Frank J. Sprague, W. J. Jenks, E. T. Greenfield—Willard, Geo T. Manser and Geo. A. Hamilton, of New York, and Harry Baum, treasurer and manager of Fidelity Carbon & Manufacturing Company, of St. Louis, were in Boston this week.

F. M. Kimball & Co. have just finished a motor of 500 volts, one-third h. p., for the Cambridge Electric Light Company. This will enable dentists and others to get power indirectly from a heavier circuit. Another motor built by the above firm is in use at the West End Office for cutting up used tickets, the work being done very effectively.

The Malden Electric Company are to add to their already well-filled station a 1,300 light alternating machine, a 125 h. p. Macintosh & Seymour engine and a 125 h. p. boiler. It is thought that an addition to their present quarters will have to be made soon, as the number of lights is constantly increasing. This company lights a territory covering 25 square miles and has over 1,000 series incandescent street lamps and nearly 300 arcs.

An Electric Lighting Exhibit.—The Suburban Light and Power Company gave an informal exhibition of the Westinghouse system of arc and incandescent electric lighting at the station on Norfolk avenue last evening. More than 100 incandescent and 30 arc lamps were used to demonstrate the company's ability to furnish a large number of lights without diminishing their brilliancy. The company has placed its lights in some 15 stores in the vicinity of Washington street.

The New England Agency of the Westinghouse Electric Company, through Mr. F. P. Barnes, its general district agent, report the following recent sales: One 1,500-light incandescent alternator to the Lewiston & Auburn Electric Light Company, of Lewiston, Me,; one 750-light incandescent alternator and one 40 alternating arc light machine to the Methuen Gas Light Company, Methuen, Mass.; one 750-light alternator, one 35 arc light Waterhouse dynamo, and a 100 h. p. Westinghouse compound engine to the Blue Hills Electric Light Company, of Canton, Mass.

The Interior Electrical Conduit.—Some very interesting experiments were tried in Boston, March 25 and 26, on the system of the Interior Electrical Conduit Company. They were conducted by Mr. E. H. Johnson, president of the company, and were designed to show the safety from fire that can be secured by the use of this system. Currents large enough to burn off the insulation were passed through wires incased in the conduit, the only result being a puff of black smoke, while by similar treatment an ordinary molding was fired throughout its entire length. Various other severe tests were made, all showing how thoroughly safe from fire a building wired through these conduits can be made. The results were most gratifying to the conduit company, and were such as should attract great public attention to the merits of the system.

The address of Captain Eugene Griffin, of the Thomson-Houston Electric Company, before the Electric Club of Harvard University, last night, on "Electrical Transmission of Power," was interesting, able and graphic, and gave a very comprehensive idea of the importance and marvellous growth of this branch of modern industry. Beginning with reference to the former definitions of this mysterious element which made it a subtle "fluid," and touching on the present idea of electrical "induction," or the "wave movement" theory of Faraday and modern scientists, Captain Griffin clearly explained the principle of the electric motor, or the reversibility of the dynamo, which is the basis of the modern system of electrical transmission of power. Instancing the telephone, the incandescent and arc lamps and the electric heater as examples of how power may be transmitted electrically, he particularly described what is generally meant by the electrical transmission of power, *i. e.*, the apparatus for converting mechanical into electrical energy, means for distributing the latter to the points of service and the motors to reconvert the electrical energy into mechanical energy, and to perform the innumerable forms of work that it does. The speaker made valuable points in showing how and why high voltages or pressures, such as are used in arc lighting, are dangerous to life, and why the low voltages, that are used on electric railways, incandescent and telegraph lines, are safe. The economical and other numerous advantages of electric over steam and similar forms of power were made apparent and evidenced, as in electric lighting, central station distribution, mill and factory work and street railway propulsion; and the growing field of mining work, where electricity lights the mine, pumps the water and drills, hoists, cuts and hauls, the various products. At present, street car propulsion is perhaps the most important branch of the electrical transmission of power. The five years increase of business in this line is most suggestive. In 1885 there were three roads with an aggregate of 7.5

miles and 13 cars. On Jan. 1, 1890, there were 251 roads in operation and under contract, with an aggregate of 1,641 miles and 2,346 cars, the growth of this application of electricity, like most of the others, being limited solely by the capacity of the factories. The Thomson-Houston Company started its first electric car on July 14, 1888, is now turning out 50 railway motors weekly and has 1,100 motors on its unfilled order list. As a result of ten years growth there are to-day about 131 arc light central stations in New England, burning over 20,000 arc lamps which represent about 17,000 h. p. electrical energy. The West End Street Railway Company are building a single station of 15,000 h. p. for electric railway work, this being but one station out of three for this one company. Dealing with the objections urged against the use of electricity, Captain Griffin showed that in New York City, where there has recently been such an ignorant, exaggerated, undiscriminating war on overhead electric lines, the aggregate number of violent deaths during the past year was 1,467. Of these, 265 resulted from falls; blows from falling objects, 36; run over by horse cars, 12; run over by cars and engines, 33; run over by wagons and trucks, 32; asphyxiated by gas, 12; and killed by electricity, 9; making just 33 per cent. more deaths from gas there last year than from electricity, and more deaths from falling sign-boards and other heavy bodies on one street, Broadway, than from either gas or electricity. During the year covered by the last report of the Boston Board of Health, the total number of deaths in that city from casualties aggregated 390, but not a single death is recorded against electricity. The 131 arc light central stations in New England have been in operation from one to ten years, distributing thousands of horse power by wires through and over all the principal cities and towns, but during that period there were only five deaths from electricity. It is most pertinent to ask what other industry comparable with the electric industry can show such a record for safety as this? Of the five deaths by electricity, four were employés of the lighting companies, and one only can be classed with the public As to the danger of fires from electricity: From Nov. 8, 1886, to May 1, 1887, in Boston, 344 fires were investigated, of which only five are returned as "cause unknown," and electric wires three. Electricity caused .009 of the fires. In the 1889 report, same city, electricity caused only two per cent. of the fires. These facts as to the electric wires in general. Concerning the electric railway wires: They carry a current of only 500 volts, while the arc light wires carry currents of from 2,000 to 6,000 volts. It is an incontestable fact that no one has ever been killed or even seriously injured by a 500-volt current from the railway wires. As to danger of fire, since the railway wires enter no buildings, they cannot of themselves cause fires. The current might be conveyed through some other circuit by wires falling on the trolley wires. The advantages of electricity over horses for running street cars, such as greater speed, greater economy in operation, cleaner streets, diminished death rate, because of the abolition of large stables, the removal of horses from the streets and the increased cleanliness of the streets, increased value of real estate, resulting from the abolition of large stables, and greater reliability of service, were all demonstrated in a way that cannot but add greatly to the public knowledge. In short, the whole address is admirable and calculated to enlighten the people on many points that are now greatly befogged and exaggerated by a too ignorant daily press, which has no right to be so, and by "conservatives" who ever oppose all progress. It is just such treatment as Captain Griffin brings to his subject, that of a practical man in an intensely practical way, that is helping the cause of electricity everywhere. It would make an excellent "tract" for circulation, and it is to be hoped the lecturer will publish it.

L. H. H.

WESTERN NOTES.

Branch Office of The Electrical World,
465 The Rookery, Chicago, March 29, 1890.

The Culmer Block, at Salt Lake City, will be lighted by 150 Thomson-Houston incandescent lights.

A Thomson-Houston 30-arc light dynamo has been added to the capacity of the Mount Clemens Electrical Company, Mich.

The Card Electric and Dynamo Company are in operation at the northwest corner of John and Front streets, Cincinnati.

Mr. Elmer P. Morris, the well-known electric railway superintendent of Cincinnati, made a flying visit to Chicago last week.

Dr. W. C. Clark's new apartment building at 39th street and Ellis avenue will be lighted from a Thomson-Houston 300-light motor type dynamo.

H. H. Prudy, Commissioner of Public Works, Chicago, is calling for bids on 325 incandescent electric fixtures for use in the House of Correction.

Mr. Jean A. Wetmore, representing the Norwich Insulated Wire Company, 58 Cedar street, New York, is in the city talking up the merits of his specialty.

Mr. L. B. Stillwell read an interesting paper on the distribution of light and power by electricity, before the Engineers' Society of Pittsburgh, on Tuesday last.

A Thomson-Houston 650-Light Alternating Current Dynamo has been added to the capacity of the Denver Electric Illuminating Co., Denver, Colo.

Frank T. Phillips, of Pittsburgh, has brought suit against the Postal Telegraph Company for gross neglect in not delivering a message, and claiming $5,000 damages.

The United Electric Street Railway Company, of Nashville, Tenn., has secured control of all the street railway lines, having paid $3,000,000 for the 50 miles of track and equipment.

Incorporations.—The Caloric Light and Fuel Company, at Chicago, to do a general lighting and heating business; capital stock, $150,000; incorporators, M. Goldsmith, H. G. Coffee, J. L. Kerr.

The Capacity of the Manitou Electric Company, Manitou Springs, Colo., has been increased by the addition of Thomson-Houston 30-light arc and 300-light incandescent machines.

Mr. James Barker, general passenger agent of the Monon Route, has kindly favored the Western office of The Electrical World with a handsomely-framed representation of their famous "velvet train."

Mr. J. W. Godfrey, General Manager of the New York Insulated Wire Company, has been in town for several days. Mr. Godfrey is en route west to the Pacific Coast, where he will cover the field thoroughly.

Mr. Ned Fox, of the Phœnix Glass Company, is again visiting the trade and showing handsome photographs or samples of globes, and all the other incandescent or arc light supplies made by the Phœnix Company.

A. W. Wright, Alma, Mich., has purchased a plant of 20 arc and 650 alternating current incandescent light capacity, of the Thomson-Houston system, to be used in the sanitarium, hotel and other public buildings.

The Union Electrical Construction Company, St. Louis, Mo., are having excellent success in the introduction of the interior conduit system among the leading architects, who are now specifying its use in many of the fine buildings.

Mr. S. S. Leonard, the western manager of the Hill Clutch Works, Cleveland, has secured the contracts for the installation of all the shafting pulleys, clutch pulleys, etc., in the new Rand-McNally Building in Chicago, and in Rathborne, Sard & Co.'s new factory in Aurora, Ill.

The Elgin City Railway Company, Elgin, Ill., announces the purchase from the Edison Company of its incandescent and arc lighting plants, thus consolidating all electric enterprises. The company increases its capital to $200,000, and will have ten miles of electric railroad in operation June 1.

Mr. F. A. C. Perrine, chief electrician of the John A. Roebling's Sons Company, stopped over in Chicago on Wednesday, en-route to Minneapolis. Mr. Perrine referred to the fact that the Roebling mills at Trenton are crowded with orders for the various wires, and that a more prosperous season has never been known.

Mr. Fred W. Best, of Denver, stopped over in Chicago on Monday while en route to New York to select an additional stock of electroliers and combination fixtures for the spring trade. Mr. Best reports business prospects unusually good; real estate commanding good, wholesome prices and the entire state rapidly settling up.

Mr. R. J. Randolph, of the Excelsior Electric Company's Chicago office, reports the sale of the following Excelsior apparatus: One 30-arc light dynamo, St. Joe, Mo.; two 30-arc light, new type dynamos to the Consolidated Electric Light Company, Kansas City, Mo.; 60 lights, new type, to Topeka, Kan., and 60 lights, new type, to Sedalia, Mo.

The Knapp Electrical Works, Chicago, are having excellent success in introducing the Young automatic safety cut-out, several companies having placed the device on every circuit. This safety device was spoken of most highly by Professor Thomas, of the Ohio University, in his late address before the Judiciary Committee of the Ohio Senate.

The Brush Electric Light Company, Cincinnati, have elected the following named officers: President, T. T. Robinson; treasurer, James Dalton; secretary, F. J. Wade. These gentlemen, with Lee H Brooks, A. G. Corrie, Julius Balke, Jr., and A. B. Champion, compose the directory. All are residents of Cincinnati, save Mr. Robinson, who resides in Boston.

Incorporations.—The Uhrichsville & Dennison Street Railway Company, Uhrichsville, O.; capital stock, $30,000. The West End Street Railway Company, at Rockford, Ill.; capital stock $30,000; to construct and operate a street railway; incorporators, J. S. Ticknor, B. A. Knight, and Otto W. Haegg. The Chicago Incandescent Lamp Company, at Chicago; capital stock, $1,000; to manufacture electrical supplies; incorporators, F. B. Caldwell, Frank J. Reed and A. Oppermann.

Decisions.—The Supreme Court of Indiana has decided in the case of William Reese vs. Western Union Telegraph Company, where the company negligently failed to deliver a message, that the plaintiff is entitled to recover what would seem to be just as a compensation for his mental anguish.

In the case of David H. Rogers vs. the same company, the court decided "that there can be no recovery under our statute where the contract was made in a foreign state."

Mr. George Cutter, Chicago, has gone east on a business trip, and will visit Boston, New York, Philadelphia and other points before his return, and will arrange for the handling of certain new specialties. During the nine months Mr. Cutter has been in business he has sold over a quarter of a million dollars worth of supplies, though he confined himself to a line of heavy electrical engineering material, not dabbling in push buttons, bells, etc. This success is phenomenal, and has all been worked up through persistent hustling and the aid of friends.

Wanted by a Chicago Syndicate.—A special dispatch from St. Joseph, Mo., says: Samuel Allerton, the millionaire pork packer of Chicago, and H. C. Fudge, a wealthy capitalist of the same city, arrived in St. Joseph to confer with the owners of the Wyatt Park and Union Electric Street Railways with the view of purchasing these lines and operating them in the future. These gentlemen are the representatives of a syndicate of Chicago capitalists which has been organized for that purpose. A proposition has been made to buy both lines, but the price has not been made public. The Wyatt Park line is nine miles in length, and the Union seven. It is expected that the deal will be closed this week

The Pumpelly Storage Battery and Motor Company, Chicago, have supplied 200 more Pumpelly cells to the local phonograph company, and have made a third shipment of 100 cells to San Francisco, for use there in connection with phonographic work. The Pumpelly Company are also making an installation of 100 cells in a prominent apartment house, to be used in furnishing light to occupants after 11 P. M. when the power plant is shut down for the night. As complete installations of this character can be made for $10 per lamp, many builders of modern structures are favorably considering the advisibility of effecting a considerable economy in the operation of their power plant, by installing a Pumpelly storage battery plant.

Telephone Quotations.—Col. S. G. Lynch, broker, 146 La Salle street, Chicago, furnishes quotations on telephone stocks at follows:

Chicago	$290@$295	Cumberland	$ 59@ $60
Central Union	58@ 59	Wisconsin	116@ 117
Michigan	96@ 98	Bell of Missouri	140@ 145
Great Southern	30@ 32	Iowa Union	23@ 25
Colorado	38@ 40	Missouri and Kansas	54@ 55
Rocky Mountain Bell	40@ 45		

ELECTRIC LIGHT STOCKS.

Chicago Arc Light and Power	$93@$94	Chicago Edison Co	$112@$113

New Companies.—Emery Electric Mining Machinery Company at Chicago; capital stock, $50,000; for the manufacture of mining machinery and electrical appliances; incorporators, J. L. Ludwig, Cyrus Emery, and B. F. Stewart. The Crosstown Electric Railway Company of St. Louis; capital stock, $100,000, half paid up; incorporated by G. Campbell, E. D. Meier, D. K. Ferguson, D. W. Brown, P. K. Marion, and C. C. Carroll. The Chillicothe Street Railway Company, of Chillicothe, Livingston County; capital stock, $15,000; incorporated by Levi Lloyd, W. G. Clark, W. M. Peatman, and C. W. Norman. The Wichita Electric Railway Company, of Wichita, Kansas; capital stock, $100,000; Directors, J. O. Davidson, Thomas G. Fitch, Geo. L. Rouse, B. H. Campbell, and C. W. Walker, all of Wichita.

The Chicago Electric Club.—The regular ticket for the election of new officers has been quietly prepared and printed, as well as proxy tickets, and a new list of members, all of which will be distributed in due season to insure the election of the regular list of officers. At the last election several proxies were offered, but refused on the statement of the secretary that a prominent member of the legal fraternity had rendered an opinion that voting by proxy was not legal. It is to be presumed that a change of circumstances has rendered necessary a more thorough investigation of the subject. The regular ticket reads: *President*, F. G. Beach; *Vice-Presidents*, 1st, F. B. Badt; 2d, Alex. Kempt; 3d, D. P. Perry; 4th, W. H. McKinlock; *Secretary*, W. A. Kreidler; *Treasurer*, F. S. Terry; *Managers*, B. E. Sunny, M. A. Knapp, F. W. Cushing, Geo. O. Fairbanks, William Taylor, F. E. Degenhardt, E. Baggot, F. W. Parker, Geo. C. Bailey, H. A. Glasier; *Membership Committee*, C. C. Haskins, Geo. Cutter, Fred DeLand.

The Heisler System.—The Heisler Electric Light Company of St. Louis report recent contracts from the following companies for their long distance incandescent electric lighting apparatus: Staten Island Light, Heat and Power Company, Port Richmond, Staten Island, N. Y.; Complete Electric Construction Company, Union Hill, N. J.; Johnstown and Gloversville Gas Light Company, Johnstown, N. Y.; Germantown Electric Light and Power Company, Germantown, Pa.; The Electric Light Company, Milledgeville, Ga.; Messrs. Rheubottom & Bond, Union City, Mich.: Pierre Electric Light and Power Company, Pierre, S. Dak. The following new Heisler plants have just been started, and are reported as operating with entire satisfaction; Holden Water Company, Holden, Mo.; Bonham Electric Light and Power Company, Bonham, Tex.; H. H. Williams & Co., Wauseon Ohio. At Holden and Wauseon these plants are doing the city lighting. Some notable shipments of electrical apparatus have just been made from St. Louis to the Republic of Mexico. The Heisler Electric Light Company recently forwarded two carloads of electrical apparatus, including dynamos, regulators, sockets, lamps, street and indoor fixtures, wire, insulators, pins, etc., etc., for the complete installation of Heisler long distance incandescent plants in the cities of Durango and Agnes Calientes. Both of these cities are to be lighted exclusively by the Heisler system, and sufficient dynamo capacity will be provided for a large amount of commercial lighting. It is expected that these plants will be in operation by May 1. On account of the high cost of fuel, the steam plant will be of the most approved type, compound condensing high-speed engines being used.

F. de L.

THE TELEPHONE.

New England Telephone and Telegraph Company.—At a meeting of the directors of this company, held March 26, a dividend of 75 cents per share was declared, payable on Thursday, May 15, 1890, to stockholders of record at the close of business on Wednesday, April 2, 1890. The transfer-book will be closed from April 3 to May 5, 1890, both days included.

The Tropical American Telephone Company reports a large increase in their exports of telephones and telephonic apparatus. Mr. Williams, who is the largest individual stockholder in the Western Electric Company, is now president of the Tropical American Telephone Company, having retired from active business some time ago. This company has exclusive right in the principal telephone patents for South America, Central America and the West Indies, and their business has in the last few years expanded continuously.

The Annual Report of the American Bell Telephone Company gives an interesting account of its prosperity and growth. The gain in total number of instruments rented by the company was more than 30,000, and the total number now in use being 444,861. Fifteen new telephone exchanges have been added during the year, making a total of 757. The total mileage of wire is now 193,213, a gain of nearly 23,000 during the year. Of this wire 27,676 miles is underground. The company is making rapid progress with its new headquarters, corner Milk and Oliver streets, Boston, and it is hoped now it may be completed for general occupation by the first of next year. After a full report of the financial standing of the company a new board of directors was elected, consisting of Francis Blake, Chas. P. Bowditch, George L. Bradley, Alex. Cochrane, W. H. Forbes, Henry S. Howe, Charles E. Hubbard, John E. Hudson, Gardner G. Hubbard, E. E. Perkins, Thomas Sanders and Howard Cochrane. During the past year $1,838,913 have been paid in dividends, besides $700,000 reserved for the depreciation account.

THE ELECTRIC LIGHT.

The Shreveport Gas and Electric Company, Shreveport, La., will install a 50 light arc machine of the Thomson-Houston system.

English, Morse & Co., Kansas City, will furnish a pair of 90 h. p. steel tubular boilers for the Manitou Electric Light Company, Manitou., Colo.

Long Bros., of Kansas City, will put in arc and incandescent light for their two office buildings. The engine will be a 70 h. p. Ideal, furnished by English, Morse & Co., of that city.

The Leavenworth Electric Light Company, of Leavenworth; capital stock, $100,000. Directors: Edward Carroll, McCum Hunt, Paul E. Haines and John Gimpes of Leavenworth, and E. Hennings of Chicago.

The Exchange Building, Kansas City, have found it necessary to increase the lighting capacity in their building by the addition of an Edison dynamo and a 40 h. p. Ideal engine. English, Morse & Co. will furnish the engine.

Fort Collins, Colo., will soon enjoy the advantages which electricity as an illuminating agent affords. The Westinghouse Electric Company has just received an order from Fort Collins for a 750-light dynamo, and the machine will be shipped without delay.

The Edison Electric Illuminating Company, of Cumberland, Md., has just placed an order with the Westinghouse Electric Company, of Pittsburgh, for one 45-light dynamo of the new alternating current arc type, which has been attracting considerable attention of late among electric lighting people.

The Westinghouse Electric Company closed an order the other day for a 750-light alternating current incandescent dynamo to go to the town of Girard, Kan. The company buying the incandescent machine has also decided to invest in a 20-light arc dynamo of the Westinghouse Company's new type. So that Girard bids fair to be a well lighted town ere long.

Holyoke, Mass.—The use of 175 gas jets has been discontinued at the mills of the Holyoke Paper Company and 160 electric lights of 10 and 16 c. p. substituted. The change is highly appreciated in the basement, where the half stock is kept, as the incandescent lamps can be swung about from one stock receptacle to another Only 12½ h p. is required to operate the system.

Hoquiam, situated in the new state of Washington, is not a very widely known town, but it is an enterprising one, and may be heard from more extensively in the future. A company to carry on an electric lighting enterprise was recently organized in Hoquiam, and has placed with the Westinghouse Electric Company an order for an alternating current incandescent dynamo of 750 lights capacity, and a 50-light arc machine of the new alternating current type.

APPLICATIONS OF POWER.

Lessened Operating Expenses.—It is said that the West End Electric road is saving 40 per cent. in operating expenses over the old method of horse power.

A New Electric Road.—A project is on foot to build an electric street railway between Gardner and East Templeton. The system to be used has not yet been decided upon.

According to the Chief Electrician, Mr. C. F. Pearson, of the West End Street Railway, the company will have 9,500 additional horse power before Nov. 1. Then the feeders will be put under ground, which will obviate the difficulties arising from their coming in contact with other wires. For three months he has been working on and has perfected a switch for cut-outs, that is, where one section of the line refuses to work because of a short circuit, the switch will cut off this section and the cars will be sent over some other route.

Five Hundred Thousand Dollars to be Invested in Street Railways in Springfield, Mo.—It has been agreed to organize a new company with a capital stock of $500,000 to purchase all property of the old company. The intention is to put electricity on the "Belt Line" as rapidly as possible, and such other lines as necessary. Mule and horse power will be retained on some branches. The company expect to generate electricity for business and private houses, lighting streets, power purposes, etc. A large power house will be erected somewhere in the Jordan valley, so as to be accessible to the Frisco and Memphis railroads, where coal can be brought in and unloaded on the premises. At present the company has not decided whether to adopt the Sprague or Thomson-Houston system. All the old stockholders are interested with the new ones in this enterprise.

MISCELLANEOUS NOTES.

A Tour of Inspection.—A party of students from the Brooklyn Polytechnic Institute were in Boston this week looking over the West End Railway.

The Browne & Sharpe Mfg. Company have just issued a new and large edition of their catalogue, giving a full description of their well-known machinery of precision.

Plans for New Subways.—Commissioner Gilroy and Engineer Kearney, of the Board of Electrical Control, held a conference last week at the Public Works Department regarding the practicability of opening more streets for subway construction, in connection with the putting down of new pavements. The conference had been agreed upon at the meeting of the Board of Electrical Control on Wednesday. A number of the representatives of the electric companies were present, and said that they would agree to any plan which would enable them to reach their customers. A large number of applications for more space were filed. A request for a Madison avenue conduit was refused by Commissioner Gilroy, on the ground that his position against reopening newly paved streets was well understood and would be adhered to without fear, favor or affection.

BUSINESS NOTICES.

Battery Cut-Out.—Attention is called to a simple device for disconnecting gas-lighting batteries if accidentally grounded. It is cheap, sensitive, never needs watching, and has no clockwork to be kept wound. Terms furnished by the Electric Supply Company, of Syracuse, N. Y., No. 105 South Warren street.

BRUSH ELECTRIC COMPANY,
CLEVELAND, Ohio, Feb. 25, 1890.

Magnolia Anti-Friction Metal Company, 74 Cortlandt street, New York.

GENTLEMEN: Some months ago we ordered a sample quantity of your Magnolia metal, for the purpose of a comparative test with the best grades of other Babbitt metal. We desired something for our Alternating Machine, which we are running at 1,125 revolutions per minute; after giving a thorough trial we found it beyond our highest anticipation, the bearings being perfectly cool. We have found it to be the best compound for journal bearings we have ever used. We are now using it in large quantities, as you are aware; which verifies our statement that we have found it superior to all other metals we have ever put into our machines. Yours truly,

(Signed) N. S. POSSONS, Supt.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

U. S. PATENTS ISSUED MARCH 18, 1890.

423,421. Apparatus for Producing Steam, Heat and Light by Electricity. Application filed Oct. 5, 1889. For generating heat, steam and light by electricity, the combination, with a source of electricity and an electric transformer, storage battery, or accumulator of an electric heating cartridge, and a steam generator adapted for conjoint operation, electric lighting apparatus electrically connected and operative connecting apparatus.

423,449. Electric Wire Molding; John A. Seely, of Brooklyn, N. Y. Application filed October 30, 1889. The invention consists of a flexible molding made of finely divided asbestos and cork with a suitable adherent, in which is embedded electric wires; and further of a short length of straight or angular molding for corners, etc., which is provided with permanent conductors and binding posts at each end for connecting the wires of the abutting sections.

423,462. Electric Switch; George Hubert Whittingham, of Baltimore, Md., Assignor to the Automatic Electric Switch Co., of same place. Application filed July 1, 1889. In a switch for electric circuits the combination of a pivoted switch lever and two helical springs, each secured to the lever at one end at a distance from its pivot, and means for moving the free end of one of the springs toward the axial line of the lever and the other away from the axial line.

423,468. Electric Connection with Car Tracks, George Gardiner Campbell, of Milwaukee, Wis. Application filed Nov. 16, 1889. The combination of an iron or steel rail of a car track with a copper wire or its equivalent, one end of the wire being inserted in the rail, the abutting surfaces of the wire and the rail being intermingled to the extent caused by casting the molten metal of the rail about the wire in the casting of the rail.

423,487. Fire or Police Telegraph; George C. McCullough, of Richmond, Indiana., Assignor of one-third to John B. Dougan, of same place. Application filed Feb. 5, 1889. In a fire and police telegraph system, the combination, with a central station, of independent out lying main line circuits, a station provided with a signal receiver in each of the circuits, a repeater at the central station connected with each of the out-lying circuits, and an independent circuit connecting the repeater with a gong at each of the out lying stations, whereby a signal will be repeated at each station, notwithstanding a break in the main line circuit thereof.

423,488. Electric Switch; Thomas F. McEvoy, of Waterbury, Conn. Application filed Nov. 25, 1889. In an electric switch the combination, with binding posts having contact points and other binding posts having swinging arms, the arms being connected by an insulated link, of a scroll cam having a shoulder and a double armed spring, the arms thereof engaging the swinging arms and also the cam, so that when the parts are in the closed position partial rotation of the cam—sufficient to permit one arm of the spring to pass off the shoulder—will instantly throw the two swinging arms to the open position, and when the parts are in the open position the same movement will throw them to the closed position.

(1) 423,494. Annunciator. (2) 423,657. Carbon Rod for Arc Lamps. (3) 423,638. Cut-Out for Electric Arc Lamps; Charles E. Scribner, of Chicago, Ill., Assignor to the Western Electric Company, of same place. Applications filed (1) August 3, 1887. (2) July 3, 1888. (3) October 26, 1889. (1) The combination, with the pivoted needle, of the surrounding coils, and the lever or catch provided with prongs projecting toward the needle and on opposite sides of the pivoted centre, whereby the lever is raised when the needle is deflected in either direction to strike either of the prongs. (2) The invention consists in a wire securely connected with the clamp proper and extending up into the inside of the tube which forms the rod, the wire being bent so as to form sure sliding contacts with the interior of the rod. The invention consists in a differentially wound lifting magnet with circuits and switching apparatus connected therewith, and so arranged that when the descent of the rod is arrested, or, in short, when, for any cause, the arc becomes abnormal ly long, it will go out, and the circuit will be maintained through the different coils of the lifting magnet so as to neutralize the same

423,495. Crossing for Electric Conductors; Henry A. Seymour, of Washington, D. C., Assignor to the Short Electric Railway Company, of Cleveland, O. A supporting device for electric conductors at crossings, consisting of an elongated plate or support having straight or practically straight lower faces for the engagement of the trolley and a raised upper portion, to the upper edge of which a conductor was secured, and an insulated support secured within an opening formed between the straight lower faces, the latter support being located and supporting a conductor above the plane of the straight lower faces.

423,527. Electrical Conductor; George E. Miller, of Lynn, Mass. Application filed January 27, 1890. An electrical conductor composed of two or more parts or sections, the proximate parts of the ends being separated to permit of the passage there between of a railway crossing gate, and having a movable arm secured to one of the proximate ends and normally extending in contact with the other of the ends to complete the circuit through both sections of the conductor, whereby the gate arm automatically opens the conductor in passing through it.

423,549. Electro-Therapeutic Appliance; Charles E. Brunning, of Stockton, Kan. Application filed Nov. 16, 1889. An improved electric body wear consisting of a series of batteries adapted to be supported from the shoulders of the wearer, a belt suspended from the batteries, and a series of batteries suspended from the belt, for contact with various portions of the body.

423,552. Electric Railway System; Ludwig Gutman, of Fort Wayne, Ind. Application filed Feb. 18, 1889. In an electric railway system, the combination of an alternating, pulsating, or intermittent current generator, feeding circuits connected thereto, and to each other, electric converters whose primary coils are connected in multiple arc to the feeder circuits, terminals to the secondary coils of the converters, electric cars provided with motors, a pair of terminals for each motor, one set of circuit with closers in a normally open circuit with one terminal of each motor and one terminal of each secondary coil, and a second set of circuit closers in a normally open circuit with the remaining terminal of each motor and one terminal of each converter and rigid connections, such as rods connecting in pairs the said circuit closers.

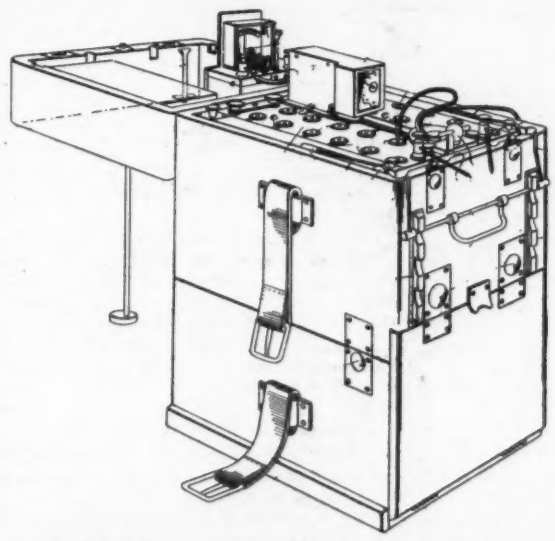
423,553. Alternating Current Electric Regulator; Ludwig Gutmann, of Fort Wayne, Ind. Application filed March 2, 1889. In an alternating current regulator, the combination of an electric converter whose primary coils are included in a supply circuit, and whose secondary coil is subdivided, and the subdivisions thereof permanently included in a work circuit and connected together by pole changers.

423,575. Individual Telephone Call; Joseph Sack, of Dusseldorf, Ger. Application filed May 1, 1889. The combination of toothed wheel having a pointer, with an arrest pawl, motion-imparting armature and lever, having ebonite pieces.

423,594. Galvanic Battery; Martin M. Clark, of Chicago, Ill., Assignor to the Western Electric Company, of same place. Application filed Dec. 9, 1889. The invention consists in a ring or collar, preferably of wood, which is placed upon the top of the jar, in combination with rubber bands or stops, one placed above and one below the same about the upper portion of the porous cup, together with the porous cup and a zinc.

423,600. Ampere Meter; Gustav A. Frei, of Boston, Mass., Assignor to the Bernstein Electric Company, of Portland, Me. Application filed Dec. 3, 1889. In an electric meter, two stationary coils placed side by side and offset combined with a movable inner coil, a pointer moved by it, and an index.

(1) 423,616. Galvanic Apparatus for Dental Surgery. (2) 423,617. Electrical Device for Use in Dental Operations; Charles W. Manker, of Nebraska City, Neb., and George F. Manker, of Bedford, Ia., Assignors of one-third to Henry E. Manker, of Elliott, Ia. Applications filed (2) Oct. 12, 1889; (1) Aug. 23, 1889. (1) The invention consists in the combination, with the electrodes running from the secondary wire of the induction coil, of rings adapted to be worn upon the fingers of the operator, either one or two fingers, as desired, for forming an electric contact with the forceps. (2) The invention consists in the combination of a battery, an induction coil, a vibrator adapted to rapidly interrupt the primary circuit of the coil and a finger



423,959.—THERAPEUTIC GALVANIC APPARATUS.

piece to be worn by the operator and adapted to close the secondary circuit.

423,654. Coin-Operated Display Apparatus; Edward H. Amet, of Chicago, Ill., Assignor to himself and Herbert A Streeter, of same place. Application filed Aug. 5, 1889. In a coin operated machinery display apparatus, the combination with a case having a coin chute and provided with a water tank at its top, of a coin operated lever, an electric motor, a battery, and electric circuit connecting said motor and battery and having a movable contact piece operated by the coin lever, a vertical shaft extending up through the tank and connected with the motor, a toy or display boat connected with and operated by the shaft, an electric light, battery, and circuit, a magnet included in the motor circuit for opening and closing the electric light circuit, a brake for the motor actuated by the magnet in the motor circuit, an induction, coil, battery and primary circuit and secondary circuit a revolving rheostat in the primary circuit operated by the motor, a vibrator, battery, and circuit for operating the vibrator.

423,697. Bell; Louis M. Pinolet, of New York, N. Y. Application filed July 15, 1889. In an electric bell, the combination of two circuits, the one main and containing a push button, and the other local and including a circuit breaker, and both containing an electric bell magnet, which is provided with a vibratory armature, the said circuit breaker consisting of a wheel provided with a hub, upon which is mounted insulation, a spring terminal passing upon the hub and means for rotating the hub, consisting of a pawl pivoted to the armature and engaging with teeth, which are provided upon the periphery of the wheel.

423,707. Electric Bell; Arthur F. Stanley, of New York, N. Y. Application filed January 30, 1890. An electro-magnetic hammer for electric bells, consisting of an armature, a shank, and a disc or hammer in one flat integral piece of iron or steel, with the disc or hammer turned at a right angle to the plane of the armature.

423,708. Static Electrical Machine; Hugo Tirmann, of Cleveland, Ohio, Assignor to the United States Milk Supplies Company. Application filed June 18, 1888. In a frictional electric machine, the combination of two compound electrics located relatively parallel and adjacent to each other, each compound electric consisting of an interior body of hard rubber or of glass, and an excitant envelope formed of a preparation of two ounces of gun cotton dissolved in a mixture of nine ounces of ether and one ounce of alcohol, the compound electrics being mounted in common on a rotary shaft.

(1) 423,732. (3) 423,734. (4) 423,735. Method of Welding Metals by Electricity; (2) 423,733. Method of and Apparatus for Electric Welding; Charles L. Coffin, of Detroit, Mich. Application filed (1) Nov. 12, 1889. (2) (3) Nov. 19, 1889. (4) Dec. 7, 1889. (2) The process of welding by electricity consisting in connecting the articles to be welded with the poles of a generator of electricity in open circuit, closing the circuit by causing an electric spark to pass the break in the circuit, and bringing the articles together to form the weld when sufficiently heated. (1) The process of welding metals electrically, consisting in bringing the surfaces to be welded in contact with a conductor or greater resistance, passing heating currents through the articles to be welded and the interposed conductor, removing said interposed conductor, and completing the weld by pressure. (3) The process of welding metal electrically, consisting in separately heating the edge of each article to be welded by passing a heating current through said article in proximity to the edge to be welded, and forming the weld by pressing the heated edges together. (4) The method of welding metals electrically, consisting in inclosing the articles to be welded between conductors, electrically heating the enclosing conductors, and forming the weld by pressing together the articles to be welded when brought to a welding heat.

423,736. Method of Welding Metals Electrically; Charles L. Coffin, of Detroit, Mich. Application filed Dec. 12, 1889. The method of welding metals electrically, consisting in bringing the edges to be welded to a welding heat by the action of an electric current, pressing them together by the attractive force of a magnet, and putting the weld under strain while subject to the action of the welding current.

423,753. Electric Burglar and Fire Alarm; William Gee, of New York, N. Y. Application filed Nov. 19, 1889. In an automatic alarm, a circuit making device composed of two diverging conducting plates adapted to be compressed between the rigid and movable members of an entrance one of the plates being provided with a screw bolt insulated and extending upward through an opening in the other plate, a thumb nut adjustable upon the bolt above the plate, a spring separating the plates and wires connecting a battery with an audible alarm through the bolt, the thumb nut, and one of the plates.

423,788. Lightning Arrester; George Seymour Maxwell, of Louisville, Ky. Application filed Dec. 4, 1889. The combination, in a lightning arrester, of an instrument to be protected, a magnet having two coils connected, respectively, with the two sides of the instruments, a circuit breaker located between the magnet and the outside circuit, and a ground therefor.

423,807. Arc Lamps; Henri Pieper, Fils, of Liege, Belgium. Application filed Sept. 21, 1889. Patented in Belgium, March 15, 1889, and in France March 23, 1889. In an electric lamp, the combination of a carbon rod, an electric circuit, two or more electrodes in contact with one end surface of the rod, one or more of the electrodes being movable with their contact points lengthwise to the rod, and means for pressing the movable electrode or electrodes against the surface of the same.

423,874. Means for Supplying Electricity to Tram-Cars; Alexander Login Lineff, of Chiswick, county of Middlesex, England. Application filed August 27, 1889. Patented in England, July 11, 1888. The means of conveying electricity to tram-cars, consisting of an electric main, a continuous flexible magnetic main, a surface contact piece or pieces, and a magnet and current collector situated on the car.

423,891. Switch for Electric Apparatus; Samuel L. Barrett, of New Orleans, La., Assignor to the Southern Electric Manufacturing and Supply Company (Limited) of same place. Application filed March 2, 1889. In a switch for electric apparatus, the combination, with the segments arranged in the arc of a circle and the resistance coils connecting the same, of a screw and an arm journaled on the screw and held down on the contact spring thereby, the armature secured to the inner end of the arm and at an angle thereto, and a contact spring arranged beneath the arm and having its outer end adapted to bear upon the segments.

PATENTS ISSUED MARCH 25, 1890.

423,897. Constant Current Motor; William Baxter, Jr., of Baltimore, Md. Application filed March 22, 1889. The invention consists in a constant current motor having the field magnetized by a current shunted from the commutator through two brushes attached to the terminals of the field coils and adapted for changing the electrical relation of the brushes to one another automatically by a centrifugal governor rotated in unison with the motor armature, and therefore effected by the load upon the motor.

(1) 423,901. (2) 423,902. (3) 423,903. Multiplex Synchronous Telegraph; Robert G. Brown, of Brooklyn, N. Y. Applications filed (1) and (2) April 27, 1889 (3) July 3, 1889. (1) In a system of multiplied synchronous telegraphy, the combination of two or more sets of synchronous mechanism, including receiving instruments with transmitter magnets and keys located in normally open local battery circuits earthed through switch contacts on either side and outlying local lines, two or more, including transmitting and receiving instruments, and switch mechanism for disconnecting the earth circuits and connecting the local line in circuit with the transmitting magnets and keys. (2) In a system of multiplex synchronous telegraphy, the combination of a series of contact segments connected in groups to two independent sets of switchboard connections and jack-plug connections, for connecting either or both of the groups to receiving and transmitting apparatus, whereby the contact segments may be utilized for different types of receiving apparatus. (3) In a system of multiplex synchronous telegraph the combination of multiplex transmitters and receivers at each end of a single main line with main line signaling batteries, also located at each end of the line, but normally open, a single repeating battery for each pair of outlying local lines normally closed therethrough, and a repeating relay, one for each apparatus, said relay having circuit connections with outlying local lines, including transmitters and receivers.

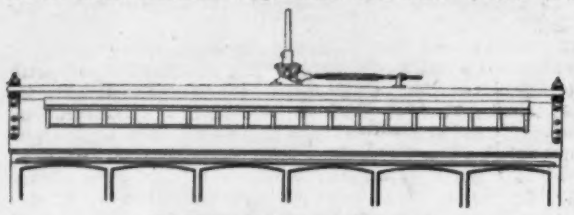
423,907. Process of Separating Magnetic Particles; Gurdon Conkling, of Glens Falls, N. Y. Application filed Aug. 7, 1889. The process of separating magnetic and non-magnetic particles which consists in causing a liquid stream containing such particles to travel downward from a higher to a lower level, and while so traveling subjecting the stream to the uninterrupted action of a stationary magnet and moving the magnetic particles

upward out of the magnetic field while the liquid stream with the non-magnetic particles is descending.

423,909. Regulator for Dynamos; Henry W. Cooley, of Boston, Mass. Application filed June 12, 1889. The invention consists in the combination, with the main armature, of an independent auxiliary coil wound on the armature and electrically connected to the main commutator to form a cycle within the machine independent of line circuit.

423,912. Commutator Brush; Philip Diehl, of Elizabeth, N. J. Application field Jan. 27, 1890. A commutator brush, consisting of a tube or receptacle and a series of loose contact devices therein.

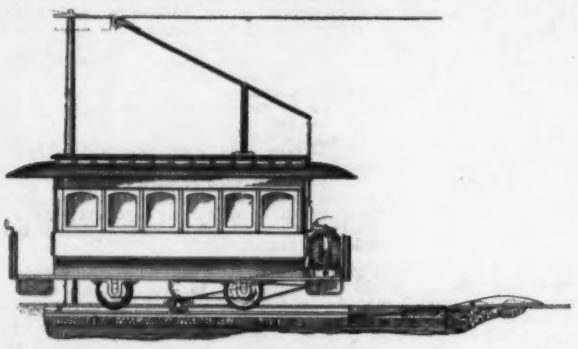
423,956. Electric Forging Machine; Robert Ross, of Vergennes, Vermont., Assignor of five-eighths to John I. Gilbert, of Malone, N. Y.; Eliza J. Ross, administratrix of said Robert Ross, deceased. Application filed June 14, 1889. In an



424,374.—Trolley Bridge.

electric metal working machine, the combination, with the mechanism which operates upon the softened metal, of two movable electrodes situated in proximity to the path of the blank or rod to be heated, holding and feeding devices for the blank connected with the metal working mechanism and independent of the movable part or electrode which makes or breaks the circuit and means connected with the electrodes for causing them intermittently to make contact with the blank.

423,959. Therapeutic Galvanic Apparatus; Theodore Schmauser, of Allegheny, Pa. Application filed Dec. 3, 1889. The invention consists of a portable electric battery, comprising two parts held together by spring catches and separable hinges. The upper part carries the elements of the battery and other attachments and the lower part carries the battery cell. The cells are raised to immerse the battery elements by means of cords passing over pulley arranged in the upper box, the box being provided on the outside with a series of notches adapted to engage a rod on the ends of the cord to hold the cells in any desired position. One of the battery elements is composed of a strip of zinc with its edges bent to form a trough for a layer of insulating material. The elements are supported by a block of insulating ma-

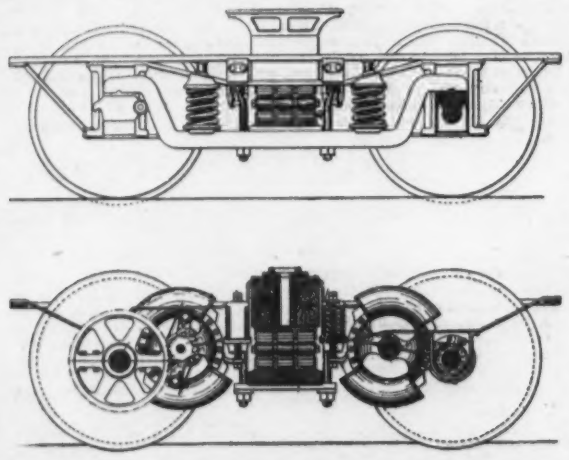


424,380.—Combined Conduit and Overhead System.

terial provided with two sockets, one for each element, which allows lateral adjustment of the elements.

(1) 423,965. Electric Valve Controller; (2) 423,966. Method of Electric Soldering, Cementing, &c.; (3) 423,967. Apparatus for Electric Soldering and Cementing; Elihu Thomson, of Lynn, Mass. Applications filed (1) November 28, 1887; (2) August 16, 1889; (3) October 16, 1889. (1) The combination of a closed receptacle partly filled with a vaporizable liquid, a heating coil adapted to give rise to a bodily movement of the liquid, a valve, and means actuated by the movement of the liquid to open or close the valve and a spring or weight for returning the valve to original position when the current ceases to flow through the heating coil. (2) The method in cementing or soldering operations in which heat is employed to heat the cementing soldering material, consisting in passing a heating electric current through a conductor contiguous to the work, but electrically insulated therefrom. (3) In an electric soldering or cementing apparatus, a circular heating conductor having its working surface covered with insulating material, and provided with a metal protective face fastened to the conductor at points of equal potential.

423,975. Controller for Electric Motors; Merle J. Wightman, of Lynn, Mass., Assignor to the Thomson-Houston Electric Company, of Connecticut. Application filed Sept. 24, 1889. The combination, with the field magnet for an electric motor of a circuit



424,436.—Electric Railway Motor.

closer and breaker in the circuit to such motor, a coil or conductor placed on such field magnet and adapted to form the seat of a retarding induced current at the time of rupture of the circuit through the motor, and means for opening and closing the circuit of the conductor when the circuit to the motor is closed and open.

423,991. Dynamo Electric Machine; Sebastian Ziani De Ferrant, of Hampstead, County of Middlesex, England. Application filed Sept. 16, 1889. In a dynamo electric machine, the combination, of a bed plate, an armature mounted in fixed bearings, field magnet movably mounted upon the bed plate, so as to be slid thereupon toward and from the armature to permit access thereto, and abutting parts or surfaces movable with the field magnets, and which abut when the field magnets are returned to the normal working position, and thereby determine without adjustment the relation of the field magnets and armature.

424,006. Telegraphy; Charles Langdon Davies, of London, England, Assignor to the Phonophore Syndicate (Limited), of same place. Application filed Oct. 1, 1888. Patented in England, Dec. 17, 1886; in Germany, Nov. 1, 1887; in France, Nov. 2, 1887; in the East Indies, Dec. 5, 1887; in Belgium, Sept. 20, 1888; in Italy, Sept. 30, 1888; in Spain, Dec. 17, 1888; and in Canada, April 11, 1889. The transmitter, consisting of a bobbin with numerous primary windings, whereby sparking is suppressed, and with secondary windings connected with the line each by one end only, and with a tongue, and with a core adjustable to vary its attraction on the tongue, and with a contact point adjustable in relation to the tongue, and with a key opening and closing contacts.

424,012. Electro-Medical Chair; Marian A. MacMaster, of Utica, N. Y. Application filed Oct. 3, 1889. In a mechanism for treatment by electricity, the combination of a chair having electric conductors passing to various parts of the chair, electrodes, electric buttons connecting with the conductors passing to various parts of the chair, the buttons being arranged with two or more in a circle with the electrode as a centre, and in two or more circles of unequal radius, the arms pivoted to the electrodes and swinging over the various circles of buttons, and foot pads consisting of a hollow tank or cistern electrically connected with the chair and the battery.

424,036. Electro-Magnetic Motor; Nikola Tesla, of New York, N. Y., assignor to the Tesla Electric Company, of same place. Application filed May 20, 1889. In an alternating current motor, the combination, with the armature and field cores, of stationary energizing coils enveloping the cores and adapted to produce polarites or poles in both, the field cores extending out from the coils and constructed so as to exhibit the magnetic effect imparted to them after the fall or cessation of current impulse producing such effect.

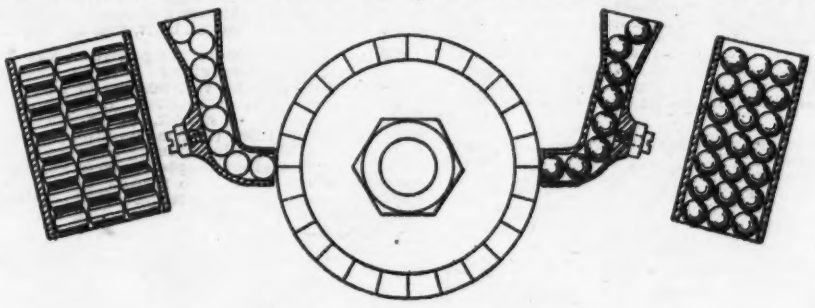
424,047. Electric Radiator; Henry Rice Butterfield and Willis Mitchell, of Waterville, Me., Assignors to the Butterfield & Mitchell Electric Cooking and Heating Company, of same place. Application filed Nov. 1, 1889. The invention consists in winding the electric wires on rings or other supports in such a way as to form a wire netting, allowing the passage of air through it, but in circuit as a continuous conductor, and offering a considerable degree of resistance to the electric current.

424,057. Underground Conduits for Electric Wires or Cables; Charles Carroll Gilman, of Eldora, Ia. Application filed Aug. 28, 1889. An underground electric conduit consisting of a number of pipes laid together, each pipe consisting of an inner metal pipe inclosing the wires, an outer porous earthenware tube treated with asphaltum and an intermediate layer of asphaltum, and the junctions of all being insulated.

424,065. Dynamo Electric Machines; Charles D. Jenney, of Indianapolis, Ind., application filed April 16, 1889. The combination, in a dynamo electric machine, of a round, straight field magnet core, pole pieces fitting tightly over the ends of the core and extending out therefrom to one side and expanding in the direction of the axis of the armature and extending in curves from the end of the core in substantially the natural direction of the principal lines of force of the field magnet.

424,070. Electric Locomotive; George W. Mansfield, of Boston, Mass. Application filed Dec. 1, 1888. In an electric locomotive, the combination with the running gear of the vehicle and a motor supporting frame swung to the running gear appropriately to allow the axles or trucks thereof and the supporting frame to swing or turn relatively to each other in taking a curve.

424,082. Electric Railway; Walter Thompson, of Meriden, Conn Application filed July 11, 1889. The invention consists in having a member, preferably insulated, projecting beyond the plane of the edges of the contact wheels of a trolley, so that such member may enter between conductors and act as a guide in seating the contact wheels against the same and as a guard to pre-



423,912.—Commutator Brush.

vent the easy displacement of the conductors and trolley from operative position, and may also act as both a guide in moving over the switch.

424,110. Coupling for Trolley Wires; Samuel Harris, of Cleveland, O., Assignor to Tom L. Johnson, of same place. Application filed Nov. 18, 1889. In combination, trolley wires having upturned ends, coupling plate having holes for receiving the same, such plate having a rounded section constituting a track from wire to wire, teats depending from the plate, such teats or ears being adapted to be pressed against the elbows of the wires to fill out the rounded sections of such elbows.

424,152. Secondary Battery; Harry H. Wardwell, of Lake Village, N. H. Application filed Oct. 14, 1889. In a secondary battery, a plate or electrode thereof having cavities formed therein, each cavity being opened at one side of the plate and having a perforated bottom formed integrally with the plate, said cavities being adapted for the retention of active material.

424,182. Circuit Closer; Joseph Anton Dempf, of Washington, D. C. Application filed Jan. 9, 1890. The invention consists of a block bored out to receive a stem inclosed within a spiral spring, the stem provided at its end with a disc adapted to connect two electrical terminals when the stem is pulled down.

(1) 424,206. Electric Railway Car; (2) 424,207. Electrically Propelled Vehicle. Rudolph M. Hunter, of Philadelphia, Pa. Application filed (1) Feb. 18, 1888. (2) June 5, 1889. In an electrically propelled vehicle, the combination of the two axles, with a worm wheel on each axle, an electric motor having its shaft extending from axle to axle, and a worm on each end meshing with the worm wheels to drive both axles simultaneously. (2) In an electrically propelled vehicle, the axles, in combination with a frame journaled upon one axle and loosely flexibly connected with the other axle between the wheels and independently of the axle boxes by means of a connection permitting both longitudinal and lateral motion, an electric motor supported upon the frame between the axles and connecting gearing between the motor shaft and axle to which the frame is journaled.

424,209. Quadruplex Relay; Francis W. Jones, of New York, N. Y. Application filed July 13, 1889. In a quadruplex telegraph the combination of a receiving neutral main line relay consisting of separate electro magnets differentially wound, each having short cores, a local magnet, all arranged to control the same armature lever, and an induction coil placed in a position neutral to outgoing currents, but active to incoming currents, and the secondary coil of the induction coil connected in local circuit with the local magnet.

424,219. Electric Alarm for Letter boxes; Wesley G. Reed, of Toronto, Ontario, Canada. Application filed Dec. 28, 1889. In a letter box having an insulated top forming one terminal of an electric circuit, and a spring actuated metal lid hinged in the top and arranged to come in direct contact with the step.

424,229. Fuse-Plug; John A. Seely, of New York, N. Y. Application filed Nov. 26, 1889. A porcelain or porcelain faced plug for cut-outs having therein a hard rubber plug for holding the metal portions.

424,273. Electric Time-Dial; Charles A. Colby and James C. Strong, of Buffalo, N. Y. Application filed Aug. 7, 1889. The combination, with the dial train of a time piece, of a ratchet actuating wheel, a lever pivoted to vibrate in a plane perpendicular to the plane of such wheel and having pallets to alternately engage and actuate the same, and an electric magnet controlled from a primary clock to actuate such lever.

424,298. Electric Railway; John C. Henry, of Kansas City, Mo., electric railway. Application filed Jan. 16, 1885. In combination with one or more electric conductors, an insulated block whereto they are connected centrally over the street, and wires supporting said blocks from two sides of the street.

424,310. Multiple Switch Boards; Milo G. Kellogg, of Hyde Park, Ill. Application filed Dec. 8, 1887. In a telephone exchange system, the combination of telephone lines divided into two classes, multiple switch boards for the lines divided into two sections, the switches for the lines, one switch for each line of one class on each board of one section, and one switch for each line of the other class on each board of the other section, annunciators for the lines, two for each line, one annunciator being located at a board of one section, and the other annunciator being located at a board of the other section, and switching apparatus at each of the boards, whereby the operator at the board may connect any line which has its annunciator at her board with any line which has its switch at her board.

424,338. Electric Meter; William McKinney, of Philadelphia, Pa. Application filed Aug. 18, 1889. In an electric meter, the combination of a clock movement, an operating shaft, a series of worms, a series of worm wheels, registering dials, and right angle levers, and a series of armature and electro-magnets so arranged that when the circuit of any magnet is closed or opened the worm and worm wheels connected therewith will be geared or ungeared, so as to register the time a current of electricity has been flowing.

(1) 424,339. Isolated System of Electric Lighting; (2) 424,340. Electric Railway; James F. McLaughlin, of Philadelphia, Pa. Application filed (1) Dec. 7, 1889; (2) Dec. 27, 1889. (1) A system of electric lighting consisting essentially of a hydraulic motor, a dynamo-electric generator driven by the same, a secondary battery adapted to be charged by the dynamo and to discharge into the light circuits, and a combined switch and valve for simultaneously controlling the circuits and the feed-water for the motor. (2) In an electric railway, the combination of insulated electric conductors disposed along and parallel with the road, with a contact truck carried by the traveling vehicle, composed of contact wheels for each conductor, the bearings of each wheel hinged, and the wheels maintained in yielding contact with opposite sides of the conductor

424,364. Electric Railway; Edmund P. Slentz, of Idlewood, and James B. McGrew, of Pittsburgh, Assignors of three-eighths to John A. Snee, of Pittsburgh, Pa. Application filed Aug. 13, 1889. In an electric railway, the combination, with two insulated conductors forming the electric circuit, of a series of conducting strips, a cylinder connecting with said strips and conductors and journaled at one end in a fixed support and its other end resting in a rotating support by which it is raised or lowered, a ball or sphere in the cylinder, actuated by gravity to make electrical connection between the conductors and strips and means by which the cylinder support is rotated automatically.

424,374. Trolley Bridge; John Stephenson, of New York, N. Y. Application filed February 4, 1890. The invention consists in supporting the parts connected with the trolley by a bridge, which consists of a frame, plank or other supporting structure placed above contact with the car-roof, and which is supported by the end or side walls of the car body, accordingly as it is of greater or less length.

(1) 424,380. Combined Conduit and Overhead System for Electric Railways. (2) 424,381. Trolley Arms for Electric Railway Cars; Charles J. Van Depoele, of Lynn, Mass. Applications filed (1) June 6, 1888; (2) Oct. 17, 1889. An electric railway system comprising an underground conduit extending along the portion of the line or way, a vertically movable contact-making device therefor, and an inclined plane at the terminus of the conduit for automatically ejecting the contact device. (2) A contact-carrying arm hinged upon a transverse axis carried by a vertical support, a tension spring arranged and sustained in a substantially horizontal position with respect to the vertical support and below the axis of the arm and connection between the tension spring and the lower part of the coutact carrying arm, whereby the outer extremity thereof is spring pressed upward.

424,387. Burglar Alarm; Nelson M. Watson, of Ecorse, Assignor of two-thirds to John B. Goundry and William A. Chamberlain, both of Denton, Mich. Application filed Oct. 15, 1889. In an electric annunciator the combination with a shaft having a contact arm moving over the terminals of a series of wires having connection with separate points of a gear fast upon the shaft and a gear loose thereon, each gear having a weighted arm to impel the gear in the same direction, a detent lever acting alternately upon the fast and loose pulley, an electro magnet or magnets attracting an armature on the detent lever, and a contact piece on one gear making electrical connection with a contact point on the other gear.

424,401. Electric Meter; William J. Bagby, of Atlanta, Ga. Application filed Nov. 18, 1889. In an electrometer, the combination of the lever, and means for operating the same, the escapement wheel of a clock, the intermediate mechanism between the lever and wheel, consisting of a pin held in suitable bearings below the end of the lever, the spring holding said pin in contact at its upper end with the lever, and a lever attached to the lower end of the pin and engaging with the escapement wheel.

424,403. Electric Heating and Cooking Device; Henry R. Butterfield, of Waterville, Me., Assignor to the Butterfield & Mitchell Electric Cooking and Heating Company, of the same place. Application filed July 27, 1889. In an electric heating or cooking device, an interior layer of insulating material, wire wound thereon, and an exterior layer of insulating material inclosing all the metal parts of the device.

424,404. Electric Flat Iron; Henry Rice Butterfield and Willis Mitchell, of Waterville, Me. Application filed Jan. 8, 1890. In combination with a hollow flat iron shell, a removable conductor normally within the same and forming part of an electric circuit.

424,406. Commutator; William F. D. Crane, of Philadelphia, Pa. Application filed Jan. 10, 1890. In a commutator for a dynamo electric machine or motor, the combination of a metallic sleeve adapted to be held by the shaft and provided with clamping portions at its ends, with the commutator segments and interposed annular portions of vitreous or earthy material, moided or cast into the requisite shape for clamping the commutator segments and clamped in position by the sleeve and its clamping parts.

424,431. Municipal Signaling Box; Frederick Pearce, of New York, N. Y., Assignor to the Gamewell Fire Alarm Telegraph Company of New York. Application filed April 10, 1889. In a multiple call box, the combination, with a rocking transmitter wheel or cylinder for transmitting multiple signals, of an annunciator or a tripping device controlled by the transmitter wheel for tripping and actuating the annunciator during the setting of a signal, whereby each signaling element of the transmitter called into action may be record d by the annunciator in advance of the transmission of the signal.

424,436. Electric Railway Motor; Frank J. Sprague, of New York, N. Y., Assignor to the Sprague Electric Railway and Motor Company, of same place. Application filed March 30, 1889. The combination, with a wheeled truck or vehicle, of a plurality of independently flexibly-supported electric motors thereon, and independent power-transmitting connections between the armature shafts of the motors and the wheels of the truck or vehicle.

424,441. Method of Manufacturing Projectiles by Electric Welding; William M. Wood, of Washington, D. C., Assignor to the Thomson Electric Welding Company, of Boston, Mass. Application filed Nov. 7, 1889. The invention consists in forming the hollow body of the projectile as a separate tubular section, separately forming the point of the projectile, and then welding the two together by the electric welding process.

Copies of the specifications and drawings complete of any of the patents mentioned in this record—or of any other patents issued since 1866—can be had for 25 cents. Give date and number, and address The W. J. Johnston Co. Ltd., Times Building, N. Y

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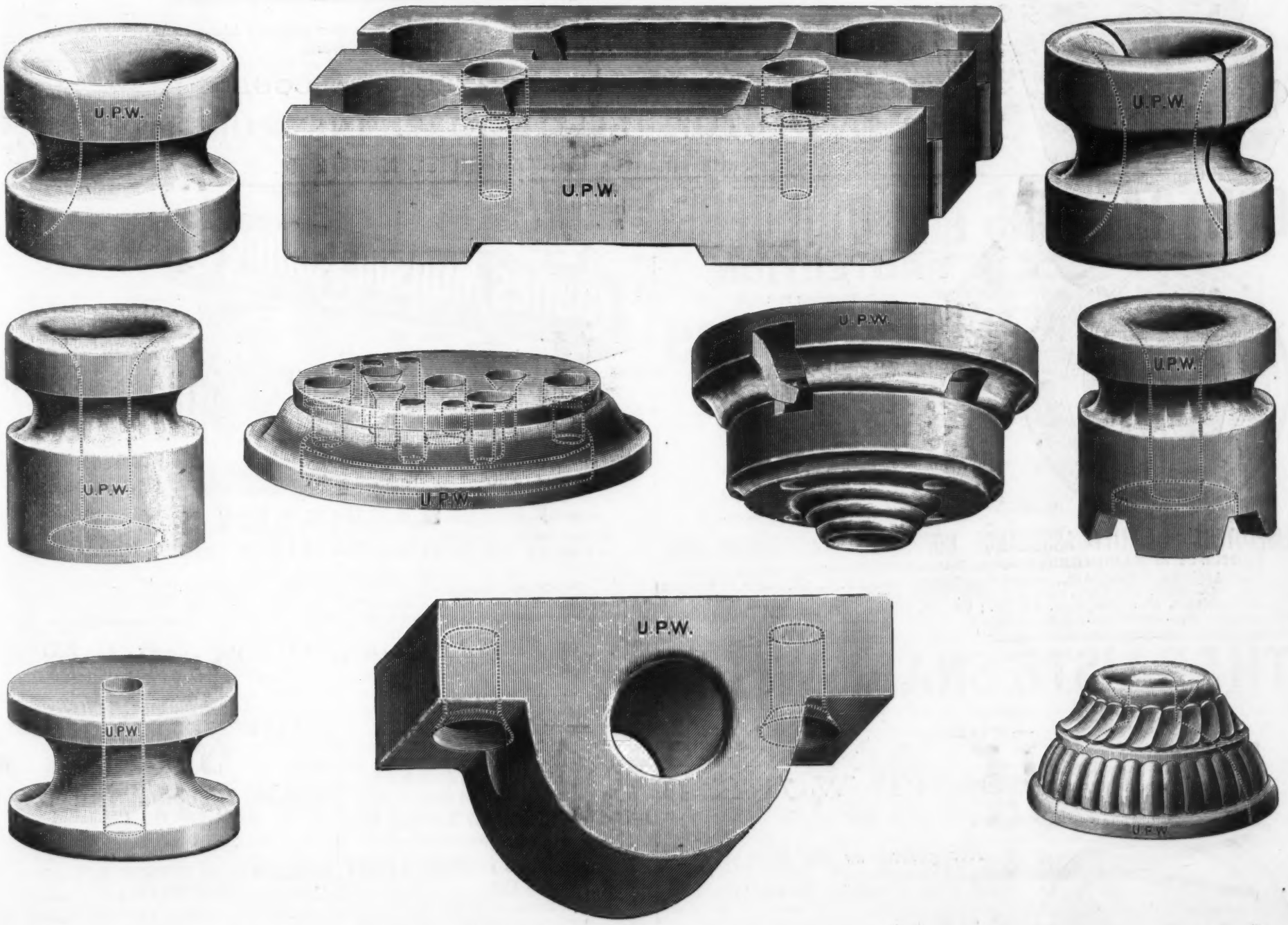

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